

AUSTRALIAN INSTITUTE OF MARINE SCIENCE  
MONOGRAPH SERIES

Volume 8

DEVELOPMENTS IN  
AUSTRALIAN MARINE SCIENCE  
AND TECHNOLOGY

by

Mereen Watson  
and  
Joe Baker

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## FOREWORD

As an island continent, Australia has the greatest accessible sea coast of any nation, far more than larger nations such as the U.S.S.R., China, the U.S. or Brazil.

The area of the seas included in the "exclusive economic zone" surrounding Australia and its offshore islands is greater than the mainland, and the seas off the Australian Antarctic Territory add far more.

Because of the extraordinary range of marine life and other physical resources from tropical to polar seas, including the unique phenomena of the Great Barrier Reef, we ought to be giving a high national priority to understanding and developing its unique potential. Unfortunately, there is little evidence of this.

As Minister responsible for the Australian Institute of Marine Science and CSIRO's Division of Fisheries and Oceanography, I am acutely conscious of the lost opportunities in previous years. The task of allocating funds between competing areas, all of high merit, is difficult and frustrating - and in retrospect decisions often look dubious. Government funding levels have been reasonably high, but the contribution of the private sector has been negligible.

Mereen Watson and Joe Baker have produced a valuable overview of the Australian situation with details of government involvement, universities, learned societies, museums, and private companies with interests in marine science. Their judgements are sound - even merciful - and the documentation valuable. May this work contribute to raising awareness of Marine Science and Technology in the bureaucratic and political world!

Barry Jones  
Minister for Science, Customs and Small Business

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## LIST OF ACRONYMS

ABRS	Australian Biological Resources Study
ACMS	Australian Centre for Maritime Studies
AIMS	Australian Institute of Marine Science
AMSA	Australian Marine Sciences Association
AMSTAC	Australian Marine Sciences and Technologies Advisory Committee
AMSTAC-FAP	Australian Marine Sciences and Technologies Advisory Committee - Funding Advisory Panel
ANCOS	Australian National Committee for Oceanic Sciences
APOC	Australian Physical Oceanography Conference
ARC	Australian Research Council
ARGS	Australian Research Grants Scheme
ASTECC	Australian Science and Technology Council
AUC	Australian Universities Commission
BMR	Bureau of Mineral Resources, Geology and Geophysics
COGS	Consortium for Ocean Geosciences of the Australian Universities
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DITAC	Department of Industry, Technology and Commerce
DOS(&T)	Department of Science (and Technology)
DPI	Department of Primary Industries and Energy
DSTO	Defence Science and Technology Organisation
FASTS	Federation of Australian Scientific and Technological Societies
FIRTA	Fishing Industry Research Trust Account
GBRC	Great Barrier Reef Committee
GBRMPA	Great Barrier Reef Marine Park Authority
IOC/WESTPAC	Intergovernmental Oceanographic Commission - Western Pacific
IPOD	International Programs of Ocean Drilling
MARAP	Marine Research Allocations Panel
MRAAC	Marine Research Allocations Advisory Committee
MSTGS	Marine Sciences and Technologies Grants Scheme
OECD	Organisation for Economic Co-operation and Development
QFMRAAC	Queen's Fellowships and Marine Research Allocations Advisory Committee
TOGA	Tropical Ocean Global Atmosphere (Experiment)



## AUTHORS' NOTE

This report is a presentation of the development of the Australian marine sciences and technologies effort and the context in which research has been conducted. It is not intended to be an exhaustive history of Australian marine science activity. The reader may discover aspects of Australia's activity in marine science and technology that have been under-represented or even overlooked. The authors apologize for any oversights. It is hoped that the information presented is sufficient to convey accurately the broad evolution, direction and current status of Australia's commitment to and involvement in marine science and technology.

The greatest omission is marine science activity conducted by the Australian military forces. These activities probably account for at least one third of all Australian Government research in the marine environment, but little detail is available. A second difficulty arose with regard to the history and development of university-sponsored marine scientific research. Australian universities represent an enormous and diverse commitment to the marine sciences, but since their efforts have never been integrated, historical records are scattered among many institutions and departments. A thorough account of university marine science activity would necessitate on-site research and was unfortunately beyond the scope of this report.

We have relied heavily on information available through Government bodies that played a major role in the development of Australian marine science and technology during the 1970s and up to 1987 including AMSTAC, the MS & T Grants Scheme and the former Department of Science. We are most grateful for the collaboration of staff and members of these bodies.

We wish to record our thanks to the Library, Word Processing and Science Communications staff of the Australian Institute of Marine Science who have facilitated the production of this volume.







## I. INTRODUCTION

The Commonwealth Government of Australia and the Governments of the Australian States and Territories have taken a long time to develop interest in and a sense of responsibility for their vast marine resources. The earliest contributions to Australia's knowledge about its marine environment came from privately-funded work by a few zealously committed academics and museum curators. Commonwealth support for marine research, especially fisheries research, emerged during the last fifty years. But it was not until the 1970s that the nation became unified in its conviction about the importance of a strong marine scientific research effort as a means of addressing its marine developmental and environmental responsibilities, that is, accessing energy reserves, improving weather forecasting, developing new food sources while maintaining the quality of the marine area (Table 1). Unfortunately that conviction, given effect in the establishment of dedicated agencies and identifiable effort, appears to have been short-lived. The surge of support in the 1970s ebbed in the 1980s as a result of political decisions, made in response to economic pressures, that were largely devoid of marine science considerations. There is a serious need for a more coordinated national marine science and technology infrastructure that would provide continuity of purpose and activity in marine-related research and development.

The phrase 'marine science and technology' denotes the scientific investigation of the oceanic and coastal waters, their influence on the coastline, and their animal and plant life, as well as their physical properties. It encompasses a wide spectrum of activities and, effectively, all scientific disciplines including the study of ocean circulation and tides, sediment and pollutants dispersal, marine biology and taxonomy, coastal and benthic ecosystems, offshore hydrocarbon and metals exploration, the chemistry of seawater, and the design of coastal and offshore structures.

To analyse marine science and technology developments in Australia necessarily involves some consideration of policy - to study the way in which decisions are made about the kind of research that is supported, its overall objectives and the level at which the research is carried out. The study of policy takes into account not only scientific issues but also the economic, legal, social and political environment. The complete background on these issues has not been accessible to the authors. Although policy issues will be evident throughout the document, its design and presentation aim to report on the evolution of Australia's attitude toward marine science and technology and to characterise the behaviour of the nation's institutions. It is hoped that by doing so, national goals may be clarified so that future decisions may be based on a comprehensive understanding and perspective about Australia's marine-related research efforts to date, in one of the largest marine areas of responsibility of any nation.<sup>1</sup>



TABLE 1

# USE OF THE OCEANS AND THE RELEVANCE OF MARINE SCIENCE AND TECHNOLOGY RESEARCH\*

	Physical Oceanography	Marine Biology	Environ- mental Sciences	Marine Chemistry	Marine Geology	Coastal & Ocean Engineering
Food from the sea: shelf and ocean fisheries, marine culture	+	++	+	+	+	
Energy: power from water movements, hydrocarbons	++	+		+	++	++
Minerals: nodules, poly- metallic sulphides, constituents of sea water	+	+		++	++	++
Drugs from marine organisms and from sea water		++	+	+		
Environmental quality: pollution, recreation	+	++	++	++	+	+
Transportation: shipping, harbours, cables, pipelines	++	+		+	+	++
Forecasts of oceanographic and meteorological phenomena	++			+	+	+
Structures and instruments in the sea	++	+		+	+	
Coastal zone protection	++	+	++		+	++

\*Sources: (1) IOC/UNESCO, Ocean Science for the Year 2000. Paris: Unesco, 1984, p. 22

(2) Authors

## II. HISTORY AND OVERVIEW

### A. Marine Science in Australia: Pre-1920s

Although the 16th century Portugese seafarer Cristavao de Mondanco has displaced Captain James Cook in history as the European to have first navigated and charted the eastern coastline of Australia, it was certainly the marine biological collections of Banks and Solander, the two naturalists who accompanied Captain Cook on his voyage aboard the *Endeavour* between 1768 and 1771, that made the first substantial contribution to marine science knowledge in Australia.<sup>2</sup> Whereas the voyage itself was underwritten by the British Government, Joseph Banks personally had invested ten thousand pounds to outfit the ship and pay the salaries of the naturalists and artists aboard. In the same tradition, for the next century-and-a-half, any progress in the marine sciences in Australia was, for the most part, dependent on individual effort and commitment.

Advancement in the marine sciences was sporadic. There were a number of French oceanographic excursions led by natural scientists Baudin, Peron, de Freycinet, Dueperrey, and de Bougainville in the early 1800s.<sup>3</sup> Perhaps the most famous of the early studies of Australia's marine life and reef origins was Charles Darwin's 1832-36 voyage on the *Beagle*. But the first attempt at a comprehensive marine scientific investigation in Australia is generally attributed to Professor J.B. Jukes, resident naturalist on the surveying voyage of the H.M.S. *Fly* in 1843, who provided a thorough account of all he observed during the long voyage through the Great Barrier Reef region.<sup>4</sup> In 1874 the marine life and physical processes off Australia's shores were again made the subject of investigation during Great Britain's renowned H.M.S. *Challenger* expedition as it circumnavigated the entire globe. Other eminent scientists studied the Great Barrier Reef and argued about its origins through the 19th and into the early 20th century.<sup>5</sup> W. Saville-Kent's weighty volume *The Great Barrier Reef of Australia*, published in 1893, is a classic reference which served to stimulate public awareness and appreciation of Australia's immense Barrier Reef complex.<sup>6</sup>

The very first, albeit short-lived, Australian marine research facility was pioneered in 1888 at Hobart by W. Saville-Kent in his capacity as Chief Inspector and Superintendent of Fisheries for the State of Tasmania. There, a number of species including oysters, grayling, and trumpeter were cultured and studied. Unfortunately the work was cut short when Saville-Kent resigned a few years later.<sup>7</sup>

In the early 1900s came a second instance of State Government involvement in marine research. The State of New South Wales employed an experienced Norwegian fisheries scientist, Harold Dannevig, who initially attempted to develop estuarine fishery stocks in Australia by importing European species. Dannevig was later employed by the Commonwealth Government as Director of Fisheries and in his Commonwealth vessel, the *Endeavour*, successfully surveyed the trawling grounds off the Australian coast until a storm at sea took his life and that of his crew in 1914.<sup>8</sup>

Museums are also notable for having conducted marine research since early times. The Australian Museum began in 1837 to catalogue shells and fishes and, before the end of the century, it had published over 100 papers on marine fishes.<sup>9</sup> The Australian Museum also employed a research worker beginning in 1891 to study coral reef fauna and has continued to support such research to the present day.<sup>10</sup> The Museum of Victoria began in 1854 to study the taxonomy of fossil and recent marine animals of

southeastern Australia. From the time of its establishment in 1862, the Queensland Museum developed a collection of molluscs and crustaceans. The South Australian Museum conducted research on fishes and molluscs beginning in 1875.

## **B. Great Barrier Reef Committee**

A major step in the development of Australian marine science was taken in 1922 when the Great Barrier Reef Committee was established by the Queensland Branch of the Royal Geographical Society of Australasia to begin systematic study of the Reef Region. The early founders envisaged a plan to carry out cartographic surveys, borings for geological study, complete biological surveys, bathymetric charting, general surveys of economic resources, and the study of coral growth under an array of conditions.<sup>11</sup>

The Great Barrier Reef Committee's plans for reef research kindled immediate interest in the academic community. In 1923 the Universities of Queensland, Sydney and Melbourne each promised the Great Barrier Reef Committee 100 pounds per annum for three years to undertake its research on the Reef.<sup>12</sup> The Committee's work was also aided by University of Sydney graduates in geology and geography on Sydney University Research Scholarships.<sup>13</sup>

Although its broad ambitions were sometimes frustrated, as it was ever to suffer from lack of funds, the Great Barrier Reef Committee nevertheless initiated and conducted a number of outstanding scientific endeavours which greatly contributed to the pool of knowledge about the biological, ecological, geomorphological and physical processes of the Great Barrier Reef. One of the most notable was the Great Barrier Reef Expedition (1928-29) which studied the Low Isles and greatly contributed to biological and ecological Reef science. A Geographical Section of the Expedition, mounted in 1936, contributed significantly to knowledge of Reef geomorphology and physical processes and produced forty maps of marine sediments.<sup>14</sup> A better understanding of the nature of coral sediment and rock was also gained after the Great Barrier Reef Committee conducted bores in Michaelmas Cay in 1926 and on Heron Island in 1937. In 1954 the Low Isles were again the subject of an expedition, further increasing the knowledge of Reef taxonomy and ecology.<sup>15</sup>

During the first years of the Great Barrier Reef Committee the Australian Government did not contribute directly to its research efforts, but saw fit to provide 1000 pounds toward the publication costs of the results of the Committee's first scientific work conducted between 1923-26.<sup>16</sup> Successful working liaisons were also established with the Royal Australian Navy and the Bureau of Meteorology.<sup>17</sup> Later the Commonwealth Government made matching contributions for some expeditions, but the level of Commonwealth Government support during the lifetime of the Great Barrier Reef Committee was disappointing for all concerned. Ironically, during the 1970s when Commonwealth interest in supporting marine scientific research on the Great Barrier Reef finally grew, the pre-eminent role of the Great Barrier Reef Committee was eclipsed by the Government's formation of new committees. In 1981 Great Barrier Reef Committee members voted to form the Australian Coral Reef Society which incorporated the Great Barrier Reef Committee and that change was formally legalised in 1987.



### C. Commonwealth Scientific and Industrial Research Organization (CSIRO)

Although the concept that government should play a major role in environmental conservation by supporting ecological science did not gain acceptance for nearly half a century, in 1926 the Commonwealth Government did show interest in supporting research aimed specifically at enhancing the output of the nation's industries. The 1926 *Scientific and Industrial Research Act* established the Council for Scientific and Industrial Research (CSIR) to do research for the benefit of Australia's primary and secondary industries. Initial efforts were aimed at problems of agriculture and forestry but gradually other divisions were added.

In 1937 the CSIR Fisheries Section was established and two years later became a full-fledged Division. Initially set up to work on problems of fish biology in Australia, the scope of the Division was later expanded to include oceanographic work, when it was determined that the physical environment has critical significance regarding the behaviour and abundance of fish stocks, and was renamed the Division of Fisheries and Oceanography in 1956. In essence the Division aimed to assess the potential of Australian fisheries and to provide advice to Government authorities on the management of fisheries resources.<sup>18</sup>

In 1949, following a dispute over "the compatibility of scientific freedom and national security", the original Act was amended to relinquish all involvement with secret or 'classified' work of a military nature.<sup>19</sup> CSIR was then renamed CSIRO - the Commonwealth Scientific and Industrial Research Organisation.

CSIRO's overall mission is to conduct strategic research aiming to :

- support industry as a whole;
- contribute to a community goal; or
- provide a scientific base for specific product and process innovations by industry.

Organisational research directions as perceived in 1984 by its Chairman, Dr. Paul Wild, had evolved from agriculture in the 1930s, to growth in manufacturing industries in the 1950s, to minerals, water supply and quality, and the environment in the 1980s.<sup>20</sup>

Marine science has rarely figured prominently in CSIRO's overall scheme.<sup>21</sup> Australia's sole national marine research facility for many years was CSIRO's laboratory at Cronulla NSW. There, scientists Rochford and Hamon of the CSIRO Division of Fisheries and Oceanography are credited with having "almost single-handedly through the 1950s and 1960s" provided a basic description of Australia's "regional waters",<sup>22</sup> as well as having contributed significantly to the field of oceanography in general. Any work at sea was primarily done using naval survey vessels. As time went on CSIRO's ability to make significant contributions to strategic marine research was greatly hampered when the pace of technological change in other parts of the scientific world, especially in computing, communications and satellite technologies, outstripped that in Australia. Certainly, the lack of its own ocean-going research vessels was a major constraint on the marine operations of the Organisation.

In 1981 the Fisheries and Oceanography Division was split into the separate Divisions of Fisheries Research and Oceanography, both located, but separately administered, first at the Cronulla laboratories and later at the CSIRO Marine Laboratories in Hobart. Their combined work includes basic and strategic fisheries

research; investigation of population dynamics, ecology and biology of commercial and potentially commercial fish resources in the Australian Fishing Zone; and research on ocean currents.

In October 1987, in a major reorganisation, a new CSIRO Institute of Natural Resources and Environment was created which included the Divisions of Fisheries and of Oceanography, although the two continue to be separately administered, as well as the Divisions of Water Resources, Wildlife and Ecology, Atmospheric Research, and the Centre for Environmental Mechanics.

With these administrative rearrangements of recent years, CSIRO's marine-related scientific and technological capabilities have been enhanced, but the perception remains that CSIRO's overall commitment to marine research continues to be less than adequate. The Chief of CSIRO's Division of Oceanography, Dr. A. McEwan, wrote in 1987 "Smart new laboratories and a new ship should not conceal the fact that Australian expenditure on effort in the marine sciences is minimal for the extent and diversity of our marine territory..."<sup>23</sup>

#### **D. Bureau of Mineral Resources, Geology and Geophysics (BMR)**

The BMR was established in 1948 to carry out geological and geophysical mapping of the Australian continent. This mapping role was extended offshore in 1965 when a major survey of the Bonaparte Gulf was undertaken using a chartered vessel. During this time the BMR also initiated Australia's first underwater marine gravity survey. In 1967 the survey was extended to the Timor Sea, and then in 1968 to the Northwest Shelf.

In 1970 the BMR began a major reconnaissance geophysical survey of the whole of the Australian continental margin using multi-channel seismic, gravity and magnetic data techniques. This data provided a basis for Australia's early United Nations Law of the Sea negotiations and a framework for petroleum exploration around the continental shelf.

Although the BMR continued to undertake a number of smaller scale surveys during the 1970s, it was ever hampered by lack of sufficient funds and research vessels for this type of research. The decision to establish a concerted national program of marine geoscience was finally made in the early 1980s and in 1982 the BMR Division of Marine Geosciences and Petroleum Geology was created as one of four BMR research Divisions.<sup>24</sup>

#### **E. Department of Primary Industries and Energy (DPI)**

Under the 1952 *Fisheries Act*, the Minister for Primary Industry was made responsible for the conservation and optimal utilisation of resources within the Australian Fishing Zone. Like CSIRO, the DPI is funded by Treasury appropriations which constitute the major source of funds for fisheries research. The *Fishing Industry Research Trust Account (FIRTA) Act* was legislated in 1969 by the Commonwealth to provide for research, education, extension and development for the benefit of the Australian fishing industry. FIRTA also falls under DPI's sphere of administrative responsibility.<sup>25</sup>



## F. State Government Support

In addition to the very early marine research carried out in the States of Tasmania and New South Wales,<sup>26</sup> the State of Queensland has a long history of supporting marine science. Early tribute was paid to Queensland for support and assistance rendered to marine scientific work by Saville-Kent in 1893 by the dedication of his famous book to the Hon. Sir Samuel Walker Griffith, Chief Justice of Queensland and later Premier of the Ministry in Queensland. Having supported the efforts of the original Great Barrier Reef Committee, the State continued to maintain interest in the Great Barrier Reef Committee's scientific work on the Reef for many years, and often provided financial support.

Much later, in 1957, it was Senator Felix Dittmer from Queensland who first posited the notion that Australia should establish a centre for marine research on the Great Barrier Reef.<sup>27</sup>

Today, support in all of the Australian States and Territories for marine research concentrates on fisheries and is drawn from budget allocations from State consolidated revenue, State research funds, and Commonwealth FIRTA grants. Fishing license fees provide revenue for each State's fisheries research account.<sup>28</sup> State fisheries administrations are often located within larger departments of Primary Industries.

The Northern Territory has emphasised research on penaeid prawns, barramundi, threadfin salmon, sharks, tuna and mackerel.<sup>29</sup> New South Wales has also concentrated on its commercially important fish, crustaceans and molluscs, notably oysters, while putting additional emphasis on marine environmental research in recent years.<sup>30</sup> South Australia has developed its program for ongoing research by focusing on its marine fishes, abalone, prawns, squid, crabs, oysters, and mussels. In conjunction with CSIRO and private companies it has also conducted experimental trawling in the Great Australian Bight to obtain knowledge about the nature of the fish stocks and their habitat.<sup>31</sup>

Since 1964, the Tasmanian research effort has grown to include scallops, abalone, rock lobster, salmonids, white bait, tuna and barracouta.<sup>32</sup> Western Australia funds research primarily at the WA Marine Research Laboratories for biological and economic research on its salmon, abalone, rock lobster and prawn fisheries.<sup>33</sup>

Whereas the State of Queensland supports a significant amount of research on the development of its major fisheries including squid, crabs, prawns and reef fishes, it has also concerned itself with mariculture development of penaeid prawns and barramundi and with studies relating to environmental problems, toxicity and diseases of certain fisheries stocks.<sup>34</sup>

In the 1940s the State of Victoria's Fisheries and Game Branch of the Department of Agriculture initiated a program of fisheries research projects that evolved and grew slowly in ensuing years,<sup>35</sup> until the 1970s when Victorian fisheries research greatly expanded.<sup>36</sup> The Marine Science Laboratories of Victoria State Government's Department of Conservation, Forests and Lands now undertakes a range of environmental and fisheries research. Some of the research work includes study of biological indicator systems as a means of monitoring marine environmental quality, the development of water quality criteria for the protection of local estuarine and marine ecosystems, study of eutrophication of marine waters, investigation of strategies for

culturing mussels, the study of whiting, jackass morwong and tiger flathead fish stocks, and the dynamics of scallop and abalone populations.<sup>37</sup>

In addition to its fisheries and environmental research, the State of Victoria also established the Victorian Institute of Marine Sciences (VIMS) in 1974 to "provide facilities for and foster, carry on and support scientific research and technological development in all branches of learning concerning or touching upon marine sciences...".<sup>38</sup> VIMS acts as a regional centre to stimulate marine research and education in Victoria.

## **G. Australian Marine Sciences Association (AMSA)**

When in 1962 the Ecological Society of Australia declined to include a marine section in its conference, indignant marine biologists called a meeting and adopted a resolution to form an Australian Association of Marine Scientists that was to become AMSA.<sup>39</sup> The 130 founding members held their inaugural meeting in May 1963 at the CSIRO Laboratories, Cronulla NSW.<sup>40</sup>

AMSA's objectives are -

"To promote liaison between scattered centres and workers in the many disciplines of marine sciences in all States, through a quarterly Bulletin, through meetings and conferences or any other means and to promote co-operation between them. Membership is open to scientists or corporate bodies engaged in marine research or to students of marine science .... AMSA aims to improve the public's 'image' of marine scientists and to forward their interests generally."<sup>41</sup>

While it has not played a role in the formulation of directions for marine research,<sup>42</sup> AMSA has provided its members, totalling over 1000 in 1987, with opportunity for professional interaction and an enhanced professional identity in Australia for over 20 years.

## **H. Universities and Museums**

**1. Early Individual Efforts.** The accomplishments of just a few individuals in the late 1800s and early 1900s are remarkable since, for many years, the budgets of universities and museums did not include anything more than minimal marine research overheads. University and museum staff had to be creative and personally dedicated in their efforts to engage in marine scientific work.

At the Australian Museum, E.P. Ramsay (1874-1894) is credited with greatly increasing the marine collections as well as publishing papers on marine fishes. Following his appointment in 1885 J.D. Ogilby published more than 100 papers on marine fishes, including "Catalogue of the Fishes of New South Wales" (1886) and "Reptiles and Fishes of Lord Howe Island" (1889). Ogilby continued to contribute to the field of fish taxonomy in his capacity as ichthyologist for the Queensland Museum between 1901 and 1915.

The South Australian Museum is indebted to Dr. Joseph Verco (later Sir Joseph), a Lecturer in Medicine at the University of Adelaide from 1887 to 1915, who had a lifelong enthusiasm for collecting and classifying marine molluscs, echinoderms, crustaceans, bryozoans and sponges. Dr. Verco's work formed the basis of the



Museum's now valuable collection of marine invertebrates. Verco's book *Combing the Seas*, published after his death, complements this collection.<sup>43</sup>

In 1918, under the direction of E.R. Waite, the South Australian Museum also established its *Records of the South Australian Museum*, a scientific periodical detailing the Museum's research activities. Waite's 1923 report "Fishes of South Australia" was a significant contribution to Australian zoology of the day.

W.B. Alexander, a marine biologist employed by the Western Australian Museum in the early 1900s, was their first staff member to publish formally on the marine fauna of Western Australia. He worked in close association with W.J. Dakin, then Professor of Biology at the newly established University of Western Australia.<sup>44</sup>

In the 1930s W.J. Dakin, who was then Professor of Zoology at the University of Sydney and well known for his popular book *Australian Seashores*,<sup>45</sup> is reported to have devoted all his modest departmental budget to the operation of his small research ship.<sup>46</sup> Taking Dakin's lead, his research assistant Isobel Bennett later went on to write authoritative texts on the natural history of the Great Barrier Reef.<sup>47</sup>

Another tangible outcome of individual initiative is the marine biological station on Heron Island. As early as 1914 and again in 1922, Queensland Museum director R.H. Harris and his successor H. Longman had expressed the desire to establish such a research station.<sup>48</sup> By the 1940s it was the dream of Professor E.J. Goddard of the University of Queensland's Department of Zoology to see that the station was established. Sadly, Goddard's activity was cut short by his untimely death in 1948, but the Great Barrier Reef Committee moved to accomplish his goal. With the help of the Queensland Government, the private sector, and the University of Queensland, the Great Barrier Reef Committee built in 1952 the "first permanent land-based centre providing living and laboratory accommodation easily accessible to a coral reef".<sup>49</sup>

The determination shown by the very few individuals who strove to pursue answers to marine-related questions during the late 1800s and the first half of this century is impressive. They conducted their activities in a professional vacuum by today's standards, depending heavily on the moral support that doubtless came from a small circle of like-minded colleagues.

**2. Marine Research by Museums - the Last 25 Years.** During the past quarter century a strong marine research program at each of Australia's State museums has evolved.

In 1965 the Australian Museum built a field station to conduct marine research on One Tree Island. In 1973 ownership of One Tree was passed to the University of Sydney when the Museum established its present station on Lizard Island. Work at the Lizard Island Research Station was further enhanced in 1983 with the delivery of the R/V Sunbird. Today the major fields of marine research at the Museum include taxonomy, systematics, morphology, ecology and zoogeography. The main subjects for study are mammals, reptiles, fishes, echinoderms, molluscs, crustaceans, and polychaetes.<sup>50</sup>

Current efforts by the South Australian Museum include the description of the marine invertebrate fauna of the Southern Ocean, preparation of a handbook on marine fishes of southern Australia, the study of marine taxonomic and population genetics using biochemical techniques, and the monitoring of populations of rare and endangered species of marine mammals.<sup>51</sup>

Between 1960 and 1975, the Western Australian Museum expanded to create new Departments of Ichthyology, Malacology, Carcinology and Marine Invertebrate Zoology. The goal at that time was to survey and document the fauna of Western Australia's 12,500 km coastline. A programme to document tropical reef fauna was initiated in the early 1970s and extensive surveys continued into the 1980s over a vast area. W.A. Museum's marine science emphases are systematics and zoogeography, with specialisation in reef fishes, echinoderms, crustaceans, barnacles, corals, molluscs, and marine mammals.<sup>52</sup>

The Queensland Museum's major contributions in marine research in the past two decades have focused on the taxonomic understanding of crabs, acroporid corals, and turbellarians. The work by C. Wallace on acroporid corals is of particular significance. "Her papers published in the 1970s are regarded as seminal, establishing a new methodology for coral taxonomy....".<sup>53</sup>

The Museum of Victoria has increased its research on the taxonomy and biogeography of benthic and pelagic invertebrates and fish in recent years. Current work includes the study of systematics of cephalopods, peracarid Crustacea and shore fishes of Southern Australia and the study of benthic, demersal and mesopelagic communities of Bass Strait and the South-eastern Australian slope.<sup>54</sup>

The Northern Territory Museum of Arts and Sciences has only recently initiated studies in marine science. Since 1981 the curatorial staff have specialised in studies of the systematics and ecology of marine animals, with special reference to Australia's tropical fauna. Specific fields of research include goat fishes and gobies, shrimp, feather stars, scale worms, soft corals, sea fans and sponges.

**3. Marine Research at Universities.** The Universities of Sydney, Melbourne, Queensland and Western Australia have long been engaged in marine research with a historic emphasis on marine biology. However each Australian university's marine research program developed independently, according to research need as perceived by the heads of departments of zoology and botany, then later geology, geography and geophysics, chemistry, biochemistry, physics, and engineering. There was no national framework for, or active interest in, university marine research for many years.

It was in the era of Prime Minister Menzies that the Australian Academy of Science was formed (1954) and began to pressure the Government about the importance of basic research of high standing. During the 1960s, the Australian Universities Commission (AUC) also pricked the Government conscience about the lack of attention to marine science.<sup>55</sup> In the 1964-66 university triennium \$20,000 was granted by the Commonwealth Government to the University of Queensland for the support of the Heron Island Research Station. A further \$30,000 was granted in the next triennium.<sup>56</sup>



Six years after the creation of the AUC, the Australian Research Grants Committee (ARGC) was established in 1965 to support university research, thus providing a mechanism by which university marine scientists could compete for financial backing within the broad scientific community. Between 1965 and 1970 marine scientists marshalled their efforts to obtain Commonwealth funding. In 1970 grants totalling \$115,420 were awarded to universities and museums for marine science projects.<sup>57</sup> While this figure indicates that there was indeed an active marine scientific community, marine science grants represented less than three percent of the total amount awarded for scientific projects that year.

A list compiled in 1968 by the Australian National Committee on Oceanographic Research (ANCOR)<sup>58</sup> of all the marine scientists then working in Australia totalled 92 names.<sup>59</sup> Of these 92, over half (47) were working at universities, 25 worked at CSIRO, 13 were at museums, 5 were in government, and 2 were listed as 'other'. Analysed by discipline, 13 were doing geological or geophysical work, 13 were in physical oceanography, and 66 were in the field of marine biology. Geographically speaking, Sydney claimed nearly half of Australia's marine scientists (41), Brisbane was home to 13, Melbourne 11, Adelaide 11, Perth 8, Townsville 4, Canberra 3, and Hobart 1.

During the late 1960s James Cook University of North Queensland and the University of New South Wales were added to the list of major marine research universities. Since that time, in response to the special funding provided by the Marine Sciences and Technologies Grants Scheme during the 1970s and 1980s, the number of universities carrying out significant levels of marine research has grown to include the Universities of Wollongong, New England, Newcastle, Macquarie, Monash, LaTrobe, Deakin, Griffith, Adelaide, Flinders University of South Australia, Murdoch, Tasmania and Curtin University (formerly the Western Australian Institute of Technology).

In his 1977 report, *An Outline of the Present Status of Marine Science in Australia*, K. Radway Allen wrote -

"Almost all the Australian universities have some involvement with marine science, although to very varying extents. Within the universities the schools or departments concerned with marine science also vary. Consistent classification on this basis is hampered by the differences in departmental structure between the universities." "...it is difficult to assess with any accuracy the funds and staff resources which are being allocated to marine science and to spread it between disciplines."<sup>60</sup>

The situation has persisted to the present day, despite increases in the level of financial commitment by the Commonwealth to the marine sciences. Although it is possible in the 1980s to trace individual research effort,<sup>61</sup> to fully characterise institutional marine science research poses a challenge that has yet to be addressed.

## I. Looking Back

In summary, the very earliest Australian marine scientific efforts were geographically scattered and internationally motivated. The overall emphasis in the 1800s was on marine biology and taxonomy. Then in the early 1900s geology became fashionable as scientists strove to solve the mystery of the origin of the Great Barrier Reef. However, due to the constraints of time and money all marine scientific activity

was confined to specific sites and sporadic study periods, making more comprehensive knowledge of ocean systems impossible.

Early Commonwealth and State Government support for marine science was intermittent and modest at best. CSIRO's mandate to do strategic research in the national interest served to restrict its activities to those immediately relevant to the economy. Thus fisheries research drew some modest investment followed later by oceanography. The BMR was restricted in its marine surveys due to lack of vessels.

Support for basic research finally began to appear in the 1950s but even as late as 1965 a major report entitled *Tertiary Education in Australia - Report of the Committee on the Future of Tertiary Education in Australia to the Australian Universities Commission* made no mention of marine-related university courses or curricula, training, or future national objectives.<sup>62</sup>

The Australian Government awakened to the need for better attention to marine sciences during the decade of the 1970s.



### III. MARINE SCIENCE AND TECHNOLOGY IN AUSTRALIA: The 1970s

#### A. The 1970s in Perspective

During the 1960s and 1970s there grew international awareness and alarm about the consequences of longstanding environmental irresponsibility. Conservation and preservation groups sprang up in all Western societies and began to exert ever-increasing political pressure on lawmakers and industry. In Australia the Wildlife Preservation Society of Queensland was founded in 1963, the Australian Conservation Foundation in 1966, and the Littoral Society of Queensland in 1967.

Between the years of 1973 and 1983 Australia enacted no fewer than thirty-one laws relating to environmental pollution, conservation, or resource management. Prior to that time there had been only six Acts in Australia that in any way pertained to environmental guardianship.<sup>63</sup> Among the new legislation was the *Australian Heritage Commission Act 1975* which provided a mechanism for advising the Government on ways to identify and conserve the National Estate and the *Great Barrier Reef Marine Park Act 1975* which represented national recognition of the importance of wise management of this natural system. In addition, the *National Parks and Wildlife Conservation Act 1975* provided for the establishment and management of parks and reserves on Australian territory and in its surrounding waters. A culmination of all these activities is the proposed Australian National Conservation Strategy, which in 1987 still awaited adoption by all but one State Government.<sup>64</sup>

#### B. The Role of Marine Scientific Research

In the 1970s the international community also began to formally recognize and address the need to preserve the marine environment in particular.<sup>65</sup> Although the 1958 Geneva Conference on the Law of the Sea had given little attention to marine scientific research, the work of the UN Seabed Committee from 1967 to 1973 and the ensuing Third UN Conference on the Law of the Sea (UNCLOS III), which began yearly sessions in 1973 and submitted a Draft Convention in 1981, entailed lengthy consideration of the subject. Specifically addressed were (1) the definition of marine scientific research, (2) the right to conduct marine scientific research, (3) promotion of marine scientific research, (4) general principles for the conduct of marine scientific research, and (5) marine scientific research as the legal basis for claims.<sup>66</sup>

In Australia, apart from the Commonwealth Government's support for some fisheries and oceanographic research, the Great Barrier Reef Committee had been for fifty years the only persistent voice proclaiming the need to carry out fundamental marine scientific research. Through its participation in UNCLOS III, the Australian Government was convinced that marine scientific research had critical importance, both on national and international fronts.

In an April 1970 Commonwealth Parliamentary Debate Mr. R. Patterson, M.P. asserted that Australia should acclaim itself as "an extremely marine oriented nation". He added -

"...we must maintain and develop a national concern about our oceanic activities to see that they are directly correlated to the needs and aspirations of the Australian community."<sup>67</sup>

Fifteen of the thirty-one environmental laws passed in Australia after 1973 relate to the prevention of marine pollution or to the conservation of marine areas.<sup>68</sup> Public environmental concern reached a peak during the controversy over the wisdom of permitting limestone mining and oil drilling in the province of the Great Barrier Reef. The argument escalated into a full-scale Royal Commission Inquiry which began in 1970 and deliberated for five years. In consequence of the Commission's findings the *Great Barrier Reef Marine Park Act 1975* banned all commercial mining and drilling in the GBR Marine Park. Additionally, in 1974, Australia ratified the World Heritage Convention that had been adopted by the General Assembly of UNESCO.<sup>69</sup> Among the six places in Australia formally recognized as meriting special protection as World Heritage sites due to their "outstanding universal value" are two marine areas: the Great Barrier Reef and the Lord Howe Island Group.

One of the conclusions drawn by the controversial Royal Commission into Exploratory and Production Drilling for Petroleum in the Area of the Great Barrier Reef stated that -

"There was wide agreement among all witnesses that present knowledge of the Reef was extremely inadequate whether in terms of charting, geology, marine biology or any other of the marine sciences....Information will need to be gathered in the disciplines of hydrology, bathymetry, marine biology, geology, ecology, chemistry and generally in the marine sciences."<sup>70</sup>

Environmental political activity and the international climate of the day all pointed to the need to increase the amount of marine scientific work going on in Australia. If the Government hadn't already been thoroughly convinced, the idea was lent solid economic rationale when the Swiss pharmaceutical firm, Hoffmann-La Roche, decided to establish an Australian research institute, the Roche Research Institute of Marine Pharmacology (RRIMP), to conduct marine research in a concerted interdisciplinary approach to find novel substances beneficial to man, his animals and his crops. Everyone, it seemed, stood to gain from more marine science and technology research.

The 1977 findings of an independent inquiry into the role of CSIRO, known as the Birch Report,<sup>71</sup> noted Australia's responsibility for "its surrounding waters" and recommended -

"Research in relation to Australian national obligations should take account of the location of Australia in the physical and international world and of our role as custodians of the Australian continent and its surrounding waters (astronomy, climatology, biological resources, oceanography etc.)"<sup>72</sup>

And further -

"Research activities should also be considered in relation to our international obligations.....and the enhancement....of Australian interaction with world science and technology."<sup>73</sup>

An indication of the momentum that existed regarding the need for marine scientific research in Australia was the passage of the *Australian Institute of Marine Science Act 1972*.

### C. Envisaging a Tropical Marine Science Institute

It was Senator Dittmer from Queensland who, in his maiden speech in 1957, made the first known documented reference to the idea that someday "a large marine



biological site on the Barrier Reef.." should be established.<sup>74</sup> The statement seems to have fallen on deaf ears at the time, but the Senator tried again in 1963 -

"I believe that there is justification for the establishment in Australia of a marine biological research station.... If such a laboratory were established [in Queensland] it would permit research not only into the fish in the area but also into marine life generally and the scientific structure of the Great Barrier Reef...Some scientific expeditions have been there and some information has been obtained but much more could be done. The Minister would be acclaimed if he were responsible for the establishment of a research station."<sup>75</sup>

It seems Prime Minister Menzies was happy to remain unacclaimed in this instance, for there is no evidence of any Ministerial response to the Queensland Senator's proddings. Not so many months later, however, similar words by men in a different forum succeeded in capturing the Government's imagination.

The story begins in 1965 when Professor Ken Back, then Warden of the University College of Townsville, (later James Cook University), submitted to the Australian Universities Commission 'Comments Relating to the Development of the University College of Townsville in 1967/69'.<sup>76</sup> In that report he stated -

"I am constantly embarrassed by having to turn down requests by interstate and overseas biologists who seek to use the University College of Townsville as a base for studies in some aspect of marine work....During my recent visit to overseas universities....considerable interest was shown in the potential at Townsville for the development of Marine Science and oceanographic work..." (p.2)

Professor Back's request for funds to develop a department of Biological Sciences with an emphasis on marine work was granted by the AUC to the sum of \$860,000 for the 1967/69 period.<sup>77</sup> When the time came in 1968 to make a submission for the next triennium the University College of Townsville's new Professor of Marine Biological Sciences, Professor Cyril Burdon-Jones, had been appointed, thus giving Professor Back a strong ally. The idea for developing Australia's marine science potential took wing:

"The progress of Marine Science within Australia, indeed within the Australasian region can be considerably accelerated over the next 5 years by the activities of a fully operational multi-discipline research and training centre in Tropical Marine Science within the University at Townsville; where various selected complementary disciplines collaborating and integrating their investigations in pure and applied fields can fully exploit and develop the enormous research potential of the natural organic and mineral resources of the area."<sup>78</sup>

The submission went on to justify the idea for a marine science centre on political, scientific, economic, and environmental grounds. There was burgeoning world interest in all aspects of marine science. Australia and all of Australasia suffered an "acute need" for full scale multi-disciplinary studies of their surrounding seas. Economies of scale demanded a centralisation of the research and training effort. And finally, a full-scale marine scientific research effort would help "ensure maximum use and the minimum abuse of our marine resources".<sup>79</sup> The report also included a shopping list of



specific requirements for such a centre: site specifications, laboratory accommodation, auxilliary research facilities, visitor and caretaker living accommodations, storage needs, aquarium and tank rooms, a sea water system, library facilities, and a rough projection of equipment costs.

The idea took hold. The Australian Universities Commission (AUC) advised the then Federal Minister for Education and Science, J.M.Fraser, that the proposal for the development of a Research Institute of Marine Science at Townsville was "imaginative and desirable". However, in 1972, the AUC was also of the opinion that a cooperative but autonomous arrangement between the University (James Cook University of North Queensland had by then evolved from the University College of Townsville) and the proposed institute would better serve national needs.<sup>80</sup> So the decision was made to sever the new Institute from the operations of James Cook University. Nevertheless Professors Back, Burdon-Jones and their Townsville colleagues deserve credit for their dream that became a reality.

#### **D. The Australian Institute of Marine Science (AIMS)**

**1. The 1970 AIMS Bill.** The idea to build and operate an Australian Marine Science Institute was refined within the Gorton Ministry. On 8 October 1969 Prime Minister Gorton announced that his Government would establish an Institute of Marine Science at Townsville because "We are an island continent and we need a much greater knowledge and understanding of the biological and physical resources in and beneath the sea around us."<sup>81</sup> On 4 March 1970 the *Australian Institute of Marine Science Bill* was presented and read to Parliament by the Honourable N.H. Bowen, Minister for Education and Science, in anticipation that the "Institute should become a centre of excellence and earn for itself and Australia a world reputation in the field of marine science."<sup>82</sup> The Bill provided for the appointment of an Interim Council to make recommendations on the functions and powers of the Institute. There was complete support for the Bill in all political parties. Political fault-finders merely noted the tardiness of the proposal that would answer such a long-standing national need.<sup>83</sup>

There was talk of a "great march of science."<sup>84</sup> The future Institute was heralded as the means by which the mysteries of the Great Barrier Reef would be solved. It would assist the Commonwealth to meet its responsibility for conserving and developing the nation's marine resources through the application of the fundamental scientific research to be carried out by the Institute. The scientific issues most often mentioned by those in Parliament were marine pollution, the crown of thorns starfish infestation, the potential of the sea as a food source for the world, and the ecologically safe development of tourism on the Reef. It was also expressed that the Institute should ultimately have branches throughout Australia so that it might address marine-related concerns of other regions.<sup>85</sup>

The rationale for the development of a new Institute was also compelling with respect to Australia's role internationally. The Institute would pave the way for more effective collection and sharing of scientific data, enhance Australia's ability to participate in important scientific work of a global nature, provide a means for solving difficult national marine environmental problems, and facilitate the worldwide exchange of ideas between scientists and technologists.<sup>86</sup> The 1970 Bill became the first *Australian Institute of Marine Science Act*.

**2. The AIMS Interim Council.** A review in some detail of the deliberations of the AIMS Interim Council is merited not only because of their relevance to the ultimate nature of AIMS, but also to illustrate the intent of the Council members to address the issue of a wider Australian involvement in marine science and technology for the future.

The terms of reference for the Interim Council of the Australian Institute of Marine Science, as outlined in Clause 7 of the Act, were to make recommendations to the Minister regarding the functions and powers of the Institute, the constitution of the Council, the site of the Institute, the nature of its cooperative relationship with James Cook University, and the associated costs of the Institute. These terms were interpreted broadly. Council Chairman, Dr. M.F.C. Day later explained -

"As we set about our task, it became perfectly obvious to me, and indeed to my colleagues, that it would be unreasonable to confine recommendations to a relatively small facet of the problem, namely to that relating to the Great Barrier Reef. If the Government was really concerned with marine science, then surely we had to consider broader questions."<sup>87</sup>

This view had been encouraged by Mr. Bowen when in his Letter of Appointment to the Interim Council he wrote that he hoped the Council "would not interpret its terms of reference too narrowly but would look in an imaginative and far-seeing way at the overall needs of Australian research in marine science."<sup>88</sup> Perhaps unfortunately for Australian marine science, Mr. Bowen was no longer Federal Minister for Education and Science when the Interim Council's recommendations were being considered in 1971.

For over a year the Interim Council worked to draft a plan.<sup>89</sup> After some delay due to requests by the new Minister for Education and Science, Mr. David Fairbairn, for modification to the Interim Council's draft report, a final report was submitted in July 1971.<sup>90</sup> It summarized the status of marine sciences in Australia, went on to discuss the pros and cons of establishing a centre in Townsville, considered the deficiencies in Australian marine science which would not be overcome by the establishment of the Institute, reviewed organizational problems in running a national centre, and discussed the educational and cooperative relationships the Institute should develop with the rest of the marine science community.

The Interim Council recognized that there were already active programs for marine research in Australian museums, universities, the CSIRO, and the Bureau of Mineral Resources which collectively emphasized fisheries, marine taxonomy, and marine geology. It recommended that the "Townsville Institute" avoid duplication of effort and instead focus on tropical marine biology, aquaculture, marine pollution, and coral predators. Glaring deficiencies in Australia's attention to physical oceanography and coastal and ocean engineering were also highlighted but the Government was advised to address these issues as separate from the specific goals of the Institute in light of its remote location. Seizing the moment, the Interim Council also boldly suggested the creation of a national body to be called the Australian Marine Science Council which would coordinate all marine research in Australia.

Of the seven major recommendations made by the Interim Council, however, only the one that encouraged the Institute to emphasise tropical research was wholly adopted by the Government.<sup>91</sup>

3. **The New AIMS Act 1972.** By March 1972, eight months after the Interim Council's report had been submitted, Malcolm Fraser had replaced David Fairbairn as Federal Minister for Education and Science. And so it was Mr. Fraser who introduced the *Australian Marine Science Bill of 1972* (to replace the 1970 Act) commending it as "a framework on which can be built a research institute which will take its place among the great marine research institutes of the world."<sup>92</sup>

Although Mr. Fraser was decidedly more empathetic and active in promoting the cause of marine science than Mr. Fairbairn, his predecessor had left a legacy which would reflect inadequate attention to all marine science matters. The 1972 Bill did not address the larger issues of marine science in Australia, but was restricted in its purpose to the establishment of the Australian Marine Science Institute. This fact was troublesome and not overlooked. "The basic problems of marine science in Australia, as revealed in the Interim Council's report, remain, and marine science in Australia cannot develop adequately until they are solved," charged one dissatisfied Member of Parliament, although the Bill was welcomed "as a first step".<sup>93</sup> Concern was also expressed that the Government recognize that sufficient and continuing funds were indispensable for the future work and reputation of the Institute.<sup>94</sup> Overall, however, the mood was one of excitement and anticipation for good things to come from this worthy investment.

4. **The Institute Underway.** Despite the 1972 Bill's speedy approval by Parliament, progress in establishing the Institute was delayed due to problems with the chosen site at Cape Pallarenda.<sup>95</sup> After extensive deliberation, a 204 hectare area at Turtle Bay on Cape Ferguson, located 50 kilometres east of Townsville was finally chosen, due to its undeveloped environment and relatively pure sea water. The first members of AIMS' scientific staff were appointed in 1974 and worked in temporary quarters for three years until the permanent facilities at Cape Ferguson were completed.

As outlined by the 1972 Act the functions of the Institute are as follows -

- (a) to carry out research in marine science;
- (b) to arrange for the carrying out of research in marine science by any other institution or person;
- (c) to co-operate with other institutions and persons in carrying out research in marine science;
- (d) to provide any other institution or person with facilities for carrying out research in marine science or otherwise assist any other institution or person in carrying out research in marine science;
- (e) to collect and disseminate information relating to marine science and, in particular, to publish reports, periodicals and other papers relating to marine science; and
- (f) to do anything incidental or conducive to the performance of any of the foregoing functions.

Clearly these functions give latitude for the Commonwealth to extend AIMS' scientific and administrative scope beyond its present tropical confines to all of Australia if it is deemed to be in the national interest at any time in the future. In the meantime its initial scientific emphasis has been consistent with its location - tropical marine science



specifically in the Coral Sea, the Great Barrier Reef, and the North Queensland coastal waters.<sup>96</sup> This emphasis was largely confirmed again in 1987, but the regional concept was expanded from Queensland to Australia's tropical waters in general.<sup>97</sup>

## **E. Government Momentum Builds**

During the time that AIMS was being established the Commonwealth also took steps to encourage marine research throughout the rest of Australia. In May 1970 the Minister for Education and Science, Mr. Bowen, introduced the Government's plan for a new program called the Queen's Fellowships in Marine Science that would draw to Australia distinguished researchers from throughout the world for one or more years of study in Australia. The Commonwealth also established the Fishing Industry Research Trust Account (FIRTA) as a means to assist the development of Australia's fisheries industry. FIRTA's first research grants were awarded in 1971.

In 1973, the Australian Research Grants Committee (ARGC) supported the marine sciences for the first time as a category of university research.<sup>98</sup> Prior to 1973, the annual number of marine science projects supported by the ARGC was never greater than sixteen.<sup>99</sup> During the 1973-75 triennium, the number swelled to sixty for research projects in marine biology, marine geology, marine chemistry, marine physics, and marine engineering. Nearly one million dollars were awarded for research grants to 15 universities and 5 museums during the 1973-75 triennium, a major increase over previous years.<sup>100</sup>

In 1974 the Commonwealth gave financial support to the State of Victoria for the establishment of the Victorian Institute of Marine Science (VIMS) to conduct research and collaborate with other institutions in Victoria in both research and teaching. In all, the establishment of AIMS, the Queen's Fellowships in Marine Science program, FIRTA, the support for VIMS, and the special funding for marine science research projects under the Australian Research Grants Committee were a strong boost to the previously neglected marine sciences.

A changing Australia would continue to compel this infusion of Commonwealth support. One pertinent example was the newly established Great Barrier Reef Marine Park Authority whose object was to "provide for the protection, wise use, understanding, and enjoyment of the Great Barrier Reef in perpetuity through the care and development of the Great Barrier Reef Marine Park." The task of declaring and zoning the Marine Park demanded extensive baseline research. Commonwealth funds were required.

Other examples of the Government's recognition of the need for increased involvement and visibility in international marine affairs include Australia's decision to conduct marine research in the Antarctic region, its membership in the United Nations' Intergovernmental Oceanographic Commission and other international organisations such as the International Whaling Commission and the UN's Food and Agriculture organization, and its participation in the UN's Conference on the Law of the Sea.

## **F. ASTEC**

During the 1970s the Australian Government also reassessed its approach to science in general. In 1974 the Labor Party Minister for Science, W.L.Morrison, issued a

Discussion Paper entitled *Towards an Australian Science Council* calling for "a more coherent national approach in the future to the development and utilisation of Australian science than has characterised the past."<sup>101</sup> An interim Australian Science and Technology Council (ASTEC) was formed in 1974 but the change in government in 1975 delayed the formation of the permanent ASTEC until 1977.

As part of ASTEC's initial broad assessment, a Working Party on Marine Sciences was set up to review the situation. In its subsequent report it estimated that expenditure for the marine sciences totalled 20-25 million dollars per annum and that the Commonwealth furnished 66 percent of all funds. Of this amount, the Commonwealth itself spent 40 percent and the rest was spread among the universities. State governments contributed 25 percent of the total and the rest was contributed and spent by industry.<sup>102</sup> The report also quoted a rough estimation of "some 900 scientists ...engaged in marine R&D in Australia"<sup>103</sup> - a tenfold increase over ANCOR's 1968 listing!

Despite a decade of noteworthy growth, there existed serious problems. First, there was no coordinating framework underpinning all the various marine R&D activities either between the various sectors of the Australian community or between organizations. Additionally, the Working Party stated -

"There is no area of the marine sciences in which Australia's R&D effort could be described as leading the world or even as being of quite outstanding quality. The work of a number of Australian marine scientists is of a reasonable standard but often, and this is particularly so in the universities, the size of research groups is below that required for the efficient conduct of research.

Particularly weak areas of marine science are civilian oceanography and the marine geosciences, largely because these disciplines are particularly dependent on ocean-going research vessels of which Australia owns none. There are only three university groups specifically concerned with the marine sciences ... and so training in the marine sciences both at the undergraduate and postgraduate level is poorly catered for."<sup>104</sup>

In the following year ASTEC produced a report *Science and Technology in Australian 1977-78* that concluded -

"The need for coordination and for ocean-going research vessels was recognised by the Interim Council of the Australian Institute of Marine Science (AIMS) in 1971 and the endorsement of these two needs has been a common feature of subsequent submissions and reports. ASTEC is concerned that the consequences of poor administration of our marine environment, and of an inadequate and unco-ordinated research effort, could be severe."<sup>105</sup>

In consequence ASTEC recommended, with highest priority for urgent action, "that greater attention be paid to the marine sciences and technologies in Australia than has been to the present time".<sup>106</sup>

A second high priority recommendation was for the formation of a permanent co-ordinating body for marine science, to be called the Australian Marine Science and Technology Advisory Committee (AMSTAC), which would report directly to the

Minister for Science.<sup>107</sup> The other two recommendations addressed the critical need for marine research vessels and for a national co-ordinating body on coastal and ocean engineering.

## G. AMSTAC

AMSTAC would thus at least partially fulfil the national advisory and coordinating role that in 1971 the AIMS Interim Council had envisaged for the Australian Marine Science Council. It would act as a filter for the Government against the many competing factions in the marine science community and distill the barrage of requests into coherent policy advice. It would not assume a lobbying position for marine science but rather be expected to "be sensitive to political and economic realities and to couch its advice and recommendations accordingly."<sup>108</sup>

The original AMSTAC, as established in 1979, did not report to the Minister for Science but was an *ad hoc* committee of ASTEC. Its first action was to arrange and conduct a series of workshops as a means to acquaint itself with the perceived problems and priorities in the marine scientific and technological community. Workshops were held in four research areas: physical oceanography, coastal and ocean engineering, marine geosciences, and marine biology. As a result AMSTAC was convinced of the need to carry out taxonomic work as a basis for biological research and to conduct more fundamental oceanographic studies essential to understanding the "practical aspects of the ocean".<sup>109</sup>

As a direct result of AMSTAC's activity ASTEC submitted a report, *Marine Sciences and Technologies in Australia: Immediate Issues*, to the Prime Minister Malcolm Fraser in July 1979. Four major recommendations were made -

- (1) That a Marine Research Allocations Panel (MARAP) be appointed to advise the Minister for Science and the Environment on the allocation of funds, and the definition of research programs and projects, within guidelines determined by AMSTAC-ASTEC.
- (2) That \$400,000 be provided in 1979-80 for allocation by the Minister on the advice of MARAP, in support of the marine sciences and technologies and that an appropriate forward commitment be made for at least two further years. Of this amount at least \$300,000 should be allocated to research on the Barrier Reef in 1979-80.
- (3) That the Australian Institute of Marine Science (AIMS) be given an additional eleven scientific staff positions, and suitable support funding, with the specific objective of accelerating research on the Great Barrier Reef particularly in the areas of environmental processes including physical and chemical oceanography, biological oceanography, both plant and animal, and reef population ecology.
- (4) That the CSIRO proposal for an oceanographic research vessel be approved, provided it is operated as a national facility; and that it is capable of as wide a range of activities as practicable.<sup>110</sup>



The Prime Minister listened. AMSTAC's policy advice was implemented.

#### H. The Senate Standing Committee

In the meantime the Senate had resolved independently in March 1979 to investigate the problem of the lack of a nationally coordinated marine research effort. It referred to the Standing Committee on Science and the Environment the issue of Australian Marine Science, especially -

- (1) The development of a marine science programme for Australia, including tropical, temperate and sub-Antarctic waters; and
- (2) the co-ordination of research efforts between the various agencies involved in the increasing development and exploitation of offshore resources for both commercial and marine park purposes, and in fisheries development.<sup>111</sup>

Although eight years had elapsed since the AIMS Interim Council had highlighted this issue, the marine scientific community now had reason to believe that at last the Commonwealth might make strong headway in addressing its heretofore haphazard national marine scientific efforts.

The optimism and achievements of one decade, however, were no guarantee for the decade ahead. The 1980s brought new problems and challenges in the form of changing political priorities, new economic circumstances, and variable administrative mechanisms.

## IV. A NEW DECADE: The 1980s

### A. Economic Realities

Whereas the 1970s were characterized by global environmental awareness and concern, the 1980s found nations occupied first and foremost in attempting to stabilise their economic bases in response to the changing economic climate.

Australia in the 1980s entered a time of fiscal restraint from which no recipients of governmental support were immune. Additionally the Government took positive steps to favour activities that promised direct benefit to the national economy in the short term.<sup>112</sup>

The marine science thrust during the 1970s had never claimed justification on the basis of quick economic return. Its overall premise for accelerated support had been the enhancement of knowledge that would lead to improved environmental management and the longer term social and economic benefits that result from the pursuit of basic science. In the light of new Government priorities in the 1980s, sustaining the momentum achieved during the 1970s for marine science would prove to be a daunting task.

### B. Policy Advice in the 1980s - Roads Not Taken

1. **The Senate Standing Committee Report.** In June 1981 the Senate Standing Committee tabled its report entitled *Australian Marine Science* in which forty-five recommendations were made. Twenty-three of these related directly to the establishment and organisation of a national coordinating body, the Marine Science Council, that would: "address areas of policy development; co-ordinate marine science research efforts; liaise with similar bodies overseas; and finance marine science research projects. Other specific issues included the need for - a national marine science policy; a coordinated marine research information system; a bathymetric and hydrographic survey of the Australian coast; better ship operations management; increased funding for physical and chemical oceanography; better facilities for coastal and ocean engineering; purchase of a vessel and other upgrades to Australia's marine geoscience effort; more attention to coastal zone protection and biological study; increased attention to marine taxonomy, fisheries research and management, the potential effects of marine pollution, and the impact of tourism on the Great Barrier Reef; improved marine technology; and greater support for graduate education in the marine sciences".<sup>113</sup>

The Senate Committee had also taken pains to redefine and discuss the need for marine science with an emphasis on its applications to industrial and social development in the 1980s.<sup>114</sup> It recognized the value of the sea to mankind - the possibilities for weather and climate forecasting, the potential for alternative energy sources, increasing food production through aquaculture, and the seemingly inevitable growth of marine-related tourism and recreational activities. The matter of marine science was all the more pressing in the light of the declared 200 nautical mile Australian Fishing Zone, the incidence and risk of pollution, the conflict between exploitive activities in and preservation of the Great Barrier Reef, and the political imperative of maintaining an active research presence in the Antarctic. Active and enhanced participation in the marine sciences was seen as the key for understanding, utilising and managing the marine environment.



Five months later, in November 1981, the Government made its reply (which, incidentally, is the only time any formal reply has been made by the Government to the marine science community about its formal policy recommendations). While praising the Committee's intent to develop a strong Australian marine science program, once again the Government refused to support the establishment of a national coordinating body with the explanation that to take such action "would be contrary to the Government's policy of financial restraint".<sup>115</sup> AMSTAC was invited to feel free, however, to take "further initiatives in liaison, consultation, and coordination" as necessary so that its advice to Government would accurately represent the marine science community.<sup>116</sup> Yet AMSTAC, as an advisory council, could never fulfil the active coordinating role envisaged for the Marine Science Council.

The *status quo*, so reviled by each of three expert committees over a decade, would endure.

The Government response was disappointing in other respects as well. No new initiatives arose from the recommendations of the Senate Report. Instead the Government noted its support for those marine research initiatives already underway and deflected to AMSTAC (or discounted altogether) the consideration of the other issues that had been raised.

**2. AMSTAC Resolutions.** Marine sciences and technologies reports were submitted to the Prime Minister through ASTEC in 1980 and 1981. Subsequently AMSTAC became independent of ASTEC and until 1987 reported directly to the Minister responsible for Science, routinely submitting its reports and policy advice through the Minister to the Government at budget time and on an *ad hoc* basis.<sup>117</sup> Table 2 represents a distillation of AMSTAC's resolutions and the subsequent response by the Government from 1979 and through the 1985/86 fiscal period. The following observations may be made:

- (1) The Government has been most willing to receive and endorse recommendations by AMSTAC about the nature and conduct of the Marine Sciences and Technologies Grants Scheme, although not at the recommended level of financial support.
- (2) The clear need for scientific research vessels was admitted and the situation redressed, in part.
- (3) Recommendations made by AMSTAC, other than on funding for the MS&T Grants Scheme and the need for research vessels, have for the most part had an appalling record of acceptance by the Government. In the past five years, out of thirty-two recommendations by AMSTAC only five have been endorsed and acted upon by the Government.

The nature of AMSTAC's recommendations also seems to have changed in recent years. Since 1984/85 the issues that AMSTAC has chosen to address have included those on a smaller scale as well as the more traditional, and arguably more appropriate, broad national issues.

Finally there are a number of issues that represent critical elements in the progress of Australian marine science about which AMSTAC has repeatedly sought support and been repeatedly ignored. The issues were researched in detail by AMSTAC Working Groups and represent careful analysis and consultation with individuals from a wide range of expertise. These include staffing increases at AIMS (82/83, 83/84, 84/85, 85/86), better support and coordination for Australia's coastal and ocean engineering



effort (83/84, 84/85, 85/86), special funding for marine taxonomy (81/82, 82/83, 83/84, 84/85, 85/86), the establishment of an Antarctic Research Fund (83/84, 84/85), and assistance to the Consortium of Island Research Stations (81/82, 82/83). The lack of response by the Government begs the question - to what end was time and energy spent by AMSTAC in submitting policy advice to the Government about the serious concerns of the marine science community?

The anticipated influence of AMSTAC on decision-making at high Government levels has not been achieved. Consequently there has been no recent growth in marine research funding (Figure 1), and there was no evidence of Government recognition of the importance of marine science and technology in the sweeping departmental reorganisation of 1987.<sup>118</sup>

### C. Administrative Shifts

To make matters all the more difficult the established administrative mechanisms for funding and policy advice in the marine sciences underwent a series of upheavals in the 1980s. A quick look at the number of acronyms used by the Commonwealth for its programs to fund marine science research projects during the period from 1979-80 to 1987 is illustrative. ASTEC's proposed Marine Research Allocations Panel (MARAP) was implemented as the AMSTAC Funding Advisory Panel (AMSTAC-FAP) in 1980-81. In the following year the Commonwealth decided to amalgamate AMSTAC-FAP with the Queen's Fellowships Committee to form the Queen's Fellowships and Marine Research Allocations Advisory Committee (QFMRAAC). In 1985 the Queens's Fellowship Scheme was transferred elsewhere so QFMRAAC shrunk by two letters to become MRAAC. In 1987 AMSTAC was combined with MRAAC and the total committee operated under the AMSTAC name. But before the year was out the Government Departments had been reorganised. As a result the Marine Sciences & Technologies Grants Scheme (MSTGS) was split from AMSTAC. Especially troubling is the fact that the two committees would thereafter exist, in separate Government departments completely divorced from each other - AMSTAC in the Department of Industry, Technology and Commerce, and MSTGS in the new Department of Employment, Education and Training. In fact the continued existence of the MSTGS in its current form is doubtful at this writing.

As noted in the previous section, AMSTAC first filled its role as marine policy advisor to the Prime Minister through ASTEC. In 1981 when AMSTAC was re-established as an advisory committee to the Minister for Science and Technology, it was effectively distanced from the higher offices of Government administration.

In the light of all the administrative changes it comes as no surprise that the enduring complaint by Australian marine scientists is the lack of a coherent marine science policy that is based on national priorities from which research plans may be developed and carried out.

TABLE 2

## AMSTAC'S RECORD OF RECOMMENDATIONS TO GOVERNMENT

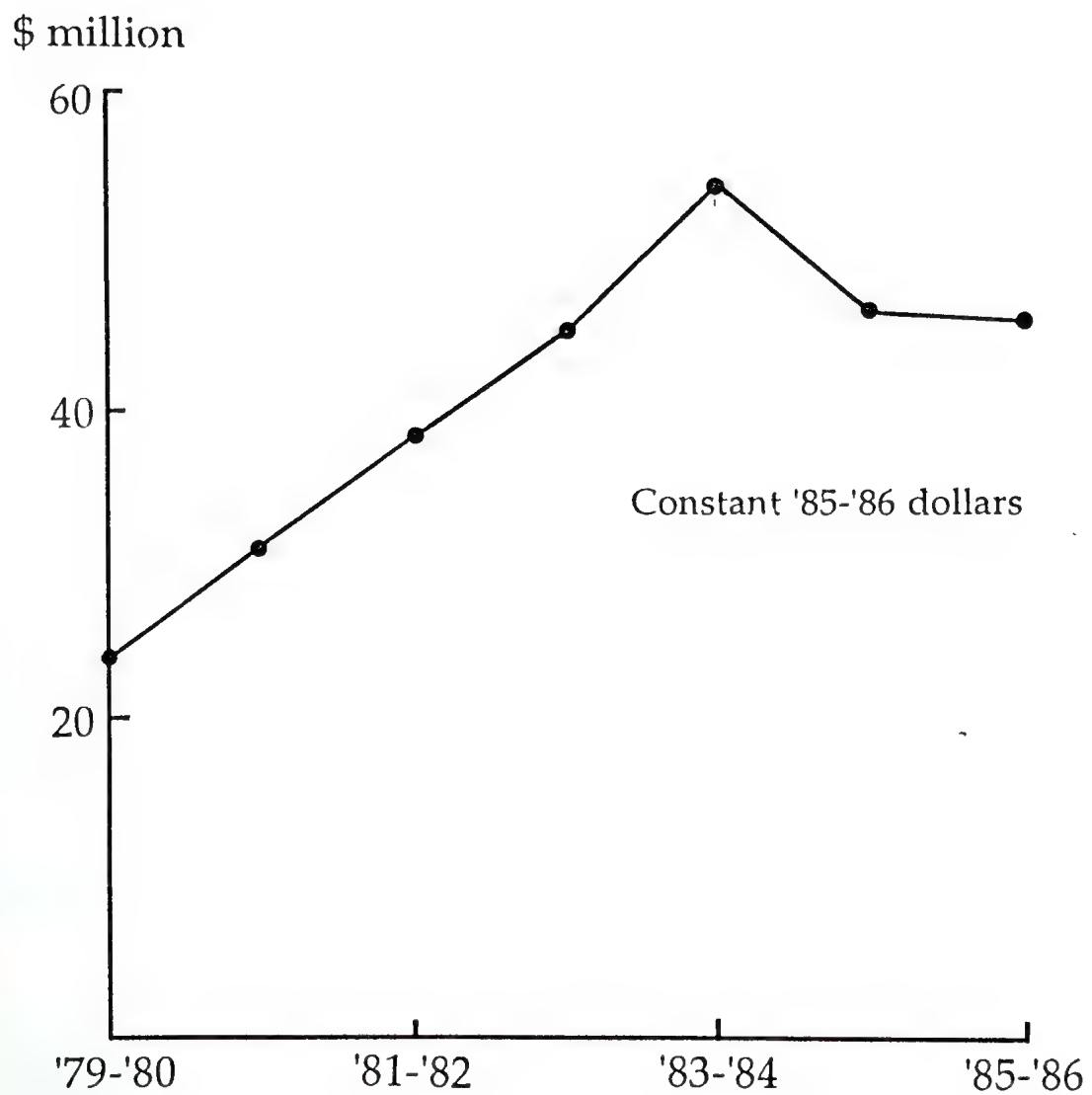
Issue	1979	80/81	81/82	82/83	83/84	84/85	85/86
MS & T Grants Scheme							
Estab/Admin	●			●		●	
Research Priorities	●		◐	●	◐	◐	◐
Research Funding	●	●	◐	◐	◐	◐	◐
Research Vessels							
Purchase/Charter	○	●	●	○	●	●	●
Operation		○	○			●	
AIMS Staffing	●	●		○	○	○	○
Marine Geosciences			●	○	◐	○	
C & O Engineering					○	○	○
Marine Taxonomy			○	○	○	○	○
Antarctic Res Fund					○	◐	
Consortium of Island Research Stations			○	○			
Information Mgmt					●		
WESTPAC Involvement					●		
Climate Study					○		
Large Equipment Fund					○		
Dugong, Endang Species						○	
Marine Policy						○	
COT Starfish							●
LANDSAT Stn Upgrade							○
Tidal Gauge Funding							○
Nat'l Museums Comm							○
Offshore Structure Environ Impact							○
Coral Microcosm Tech							○
High Tech Applications in GBR							○

Key: ● Recommendation fully adopted  
 ◐ Recommendation partially adopted  
 ○ No action taken

FIGURE 1

GROSS COMMONWEALTH EXPENDITURE  
ON CIVIL MARINE SCIENCE AND TECHNOLOGY  
1979/80 - 1985/86

Constant 85/86 Dollars  
(\$ million)





## D. Efforts at Coordination and Communication

The number of agencies involved in the marine sciences is impressive. In 1987 nine Commonwealth Ministries were in charge of a large number of agencies and programs that involved the marine sciences. (See Table 3) In addition, State Government agencies, universities, professional organizations and private companies were all active to varying degrees in the marine sciences and functioned, for the most part, without any broad directives at the national level. An exception to this rule developed in 1985 when the then Minister for Science, Mr. Barry Jones, in consultation with AMSTAC began to develop priorities for the Marine Sciences and Technologies Granting Scheme. Yet these priorities were directed at individual researchers or to groups of research workers and were subject to yearly revision. They did not provide guidance for agencies attempting to develop long term research programs.

Despite the enduring dilemma of the lack of any national framework for directing the marine science effort in Australia, there have been a number of attempts by AMSTAC, other Government authorities, and scientists themselves to facilitate coordination and communication nationwide.

1. **AMSTAC Workshops.** Since 1985 AMSTAC has endeavoured to fulfil the role of coordinator of the marine science community, within the constraints of its terms of reference, by organising coordination workshops between all Commonwealth agencies. Each agency is requested to describe and discuss its three year forward plan for marine research. As a result of these meetings, AMSTAC has attempted to engender links between agencies and enhance communication.<sup>119</sup>

2. **Australian Marine Research In Progress (AMRIP).** Another positive step, taken in response to the 1981 Senate Standing Committee report, was the provision of funds for the development of a computer-based information system on current marine research activity in Australia. The Department of Science, the Great Barrier Reef Marine Park Authority and the Victorian Institute of Marine Sciences, with the assistance of CSIRO's Central Information Service, collaborated on the first (1982) and second (1983) edition of AMRIP—*Australian Marine Research in Progress*. For the third edition of AMRIP (1985) and henceforth, AIMS has assumed the role of primary coordinator for AMRIP, replacing the Department of Science. AMRIP is available both in book form and as a machine readable data base on AUSTRALIS accessed on-line through CSIRONET, the Australia-wide computer network operated by CSIRO. The information is intended for use by researchers, research organisations, and the users of research results to facilitate the flow and accessibility of information about ongoing research.

In its 1985 edition, AMRIP indexed hundreds of marine research projects being conducted by individuals in 182 Commonwealth and State agencies and departments, universities, and private companies both in Australia and overseas.

### 3. Professional Organisations.

(a) **Federation of Australian Scientific and Technological Societies (FASTS).** FASTS was created in November 1985 to provide a coordinated representation of the views of the scientific community to Government.<sup>120</sup> It boasts a membership of 70 professional organisations totalling over 60,000 scientists, technologists and educators.<sup>121</sup> Both AMSA and the Australian Coral Reef Society have joined the Federation in a move to enhance the promotion of the interests of the marine sciences, and of Australian science in general, in the political forum.

TABLE 3

**COMMONWEALTH AGENCIES DEALING WITH MARINE SCIENCE & TECHNOLOGY**

Prime Minister	Australian Science and Technology Council (ASTEC)
Industry, Technology and Commerce	CSIRO Institute of Natural Resources and Environment <ul style="list-style-type: none"> <li>- Oceanography</li> <li>- Fisheries Research</li> <li>- Atmospheric Research</li> </ul> CSIRO Office of Space Science and Applications AIMS National Facility Oceanographic Research Vessel Steering Committee AMSTAC Science Policy International Science AUSTRADE Technology and Business Efficiency Division
Transport and Communications	Maritime Safety Division
Foreign Affairs and Trade	Legal and Consular Division Australian International Development Assistance Bureau Australian Centre for International Agricultural Research
Defence	Navy Office Defence Science and Technology Organisation
Employment, Education and Training	MSTGS** ARGS** National Research Fellowships** Commonwealth Tertiary Education Commission (to be reorganised) Australian Commission on UNESCO
Primary Industries and Energy	Bureau of Mineral Resources, Geology and Geophysics (BMR) Australian Fisheries Service Bureau of Rural Science Mineral Policy Branch
Arts, Sport, the Environment, Tourism and Territories	Great Barrier Reef Marine Park Authority (GBRMPA) Australian National Parks and Wildlife Service (ANPWS) Antarctic Division Bureau of Flora and Fauna Antarctic Science Advisory Committee Environmental Policy Division
Administrative Services	Division of National Mapping Division of Engineering Bureau of Meteorology Australian Survey Office

\*Source: AMSTAC, September 1987

\*\*To become part of the Australian Research Council



(b) Australian Coral Reef Society. This Society incorporates the former Great Barrier Reef Committee and promotes the scientific study of Australian coral reefs by holding workshops, awarding student research moneys, and producing a yearly newsletter.

(c) Australian Marine Sciences Association (AMSA). As the largest marine professional association in Australia, AMSA serves a critical role for communication in the marine research community. There is also the intention that AMSA may further evolve as a strong component of the FASTS lobby for the interests of all marine scientists in the nation's political arena.<sup>122</sup>

Membership has been dominated traditionally by marine biologists as this group claims the largest number of active researchers in Australian marine science. Recently AMSA has taken steps to involve itself to a greater degree with other fields of marine science. For instance, the Australian Physical Oceanographers Conference (APOC), has recently taken up membership in AMSA and the two groups held their annual conferences jointly in 1987.

(d) Australian National Committee for Oceanic Sciences (ANCOS) is a committee of the Australian Academy of Science, with additional representation from the Royal Australian Navy Hydrographer's Office and AMSA. ANCOS meets annually and advises the Academy on all matters relating to oceanic sciences. The Committee was not very active between 1980 and 1984 but has assumed a more positive role since 1984 in commenting on Government initiatives in marine science as well as maintaining links with similar agencies in other countries. Overall the Academy of Science does not have a strong representation of marine scientists, and marine topics do not appear to rate high priority.

(e) Australian Physical Oceanography Conference (APOC). Established in the mid-1970s, APOC has met once every two years since that time and provides a forum for the discussion of current activities and progress in Australian physical oceanography. Owing to the small number of physical oceanographers employed in Australia, the conferences are modest in scale. The 1987 APOC was attended by 63 individuals and was held in conjunction with the AMSA conference.<sup>123</sup> APOC became affiliated with AMSA in an organisational structure amalgamation in 1986, but still retains the opportunity to conduct independent meetings.

(f) Consortium for Ocean Geosciences of the Australian Universities (COGS). Since establishing COGS in 1975 university geoscientists have worked to foster co-operative research, to facilitate access to research vessels, and to coordinate the participation by Australian geoscientists in international geoscience cruises. It has also striven to achieve Commonwealth support for Australia's participation in the the International Programs of Ocean Drilling (IPOD). In recent years COGS has lobbied for increased funding for the marine geosciences, arguing that the level of funding for marine geoscientific research has not been at all commensurate with the earnings that Australia has reaped as a result of its geoscientific research.<sup>124</sup>

(g) The Australian Centre for Maritime Studies Inc. (ACMS). This independent non-profit organisation based in Canberra was established in 1981 to generate greater awareness of maritime affairs in Australia. In 1985/86 ACMS had 40 corporate, 80 institutional, and 130 individual members. Its objectives are to disseminate information, promote and facilitate existing research, undertake research in areas where work is not presently being undertaken, to promote discussion across disciplinary boundaries, and to



act as a bridge between industries and between industries and government. Through its publications and conferences, the Centre has established a mechanism for interaction by scientists with the greater maritime community about marine policy matters.<sup>125</sup>

(h) **The Australian Marine Sciences Consortium.** The Australian Marine Sciences Consortium initially established in 1984 in Sydney, and with membership of the Universities of Sydney, New South Wales and Macquarie together with the New South Wales Institute of Technology and the Royal Australian Naval College, has recently been extended in membership to include additional Institutions in New South Wales and also in Queensland and Victoria. The Consortium seeks to promote interactions aimed at strengthening each individual research organisation. Its specific objectives are (a) to act as a coordinating body to provide increased stimulus for marine science research; (b) to provide a coordinating centre or centres to enable interaction between members in the fields of marine science in Government, semi-Government and statutory bodies, in private organisations and in tertiary institutions; (c) to facilitate collaboration within and between universities, colleges, Government departments and industry in the general areas of post-graduate research and training activities in the marine sciences; (d) to provide common facilities for post-graduate research and training; and (e) to provide a focal point for the provision of public education in marine science.

**4. IOC/WESTPAC.** Apart from the ongoing collaborative relationships initiated by Australian marine scientists with scientists throughout the world, the Commonwealth of Australia has taken an active role in promoting marine scientific interaction with other countries by virtue of its commitment to IOC/WESTPAC. Established by the Intergovernmental Oceanographic Commission (IOC) in 1979, IOC/WESTPAC is a regional program that seeks to promote and stimulate communication and collaboration between scientists in the South East Asian and West Pacific regions. The perceived benefits of involvement with IOC/WESTPAC are both scientific - in that sharing data and research results hopefully leads to reduced duplication of effort and greater standardisation of data and methodologies - and political, as an enhancement to foreign relations.

Australia has been a major contributor to workshops, seminars, training programs and symposia that bring together scientists for the purposes of multi-disciplinary and regional problem-solving.<sup>126</sup> An Australian, Dr. John Bunt, also served as the chairman of IOC/WESTPAC between 1983 and 1987. The Commonwealth Government continues to actively promote IOC/WESTPAC and maintains a liaison office in Canberra.

**5. Other Agencies.** The Australian Centre for International Agricultural Research (ACIAR) supports marine as well as terrestrial programs. Currently it supports a giant clam mariculture program, focused in Australia at James Cook University of North Queensland.

The Australian National Commission for UNESCO has also supported marine programs, notably on mangrove and coral reef use and management. It has an ongoing interest in defining and addressing research and training needs for the marine sciences and technologies towards the year 2000.

## E. Funding for the Marine Sciences: Where Has the Money Gone?

1. **Marine Sciences and Technologies Grants Scheme (MSTGS).** One starting point for understanding the kind of marine research that has been supported in Australia is the Marine Sciences and Technologies Grants Scheme (MSTGS) founded as AMSTAC's Funding Advisory Panel (AMSTAC-FAP) in 1979. MSTGS was set up to -

"address the principal restraints that operate to inhibit the investigation of the sea; to promote some infrastructural support; to create opportunities for team efforts; to create opportunities for recruitment of personnel and the development of expertise; to maximise and coordinate the use of facilities; and to address priority target areas that are important to the nation's understanding of its surrounding oceans and the resources that they harbour."<sup>127</sup>

Later the Scheme was administered by the Marine Research Allocations Advisory Committee (MRAAC) and was closely aligned with AMSTAC until the 1987 Government reorganisation.

Each year MSTGS emphasised to its applicants its intention to support research that:

- is of high priority in the national interest and which would not otherwise be carried out;
- will utilise the collective skills and expertise of different specialists from one or more organisations;
- is likely to produce results of significance in the short to medium term for more effective management of the marine environment and the development of marine technologies;
- is able to stimulate education and training in the marine sciences and technologies.<sup>128</sup>

Table 4 shows the number of grants supported each year by MSTGS and the total amount of dollars spent, in both actual and 85/86 constant dollar terms.<sup>129</sup> Figures 2 and 3 show the overall trends of the Grants Scheme since 1979. After the stimulating surge of 1983/84 there has been a regrettable decline in funding momentum.<sup>130</sup> The average funding amount for individual projects has been fairly stable yet in latter years there appears to have been an attempt to fund the greatest possible number of projects by slightly reducing the amount of funds awarded to any one project (Figure 4).

TABLE 4

**YEARLY ALLOCATIONS TO MSTGS**  
(in millions of \$)

Year	No. of Grants	Actual Allocation	Value in Constant 85/86 Dollars*
79/80	24	.394	.630
80/81	95	1.9	2.778
81/82	98	1.899	2.487
82/83	92	2.119	2.543
83/84	137	3.759	4.247
1985	156	3.828	3.943
1986	150	3.827	3.827

\*Figured with the Universities aggregate price deflator published in the Australian S & T Budget Brief 1985 produced by the Department of Science and used by AMSTAC in its 1986 review of the MSTGS (p. 10).



FIGURE 2  
TOTAL ALLOCATIONS TO MSTGS  
(in millions \$)  
Constant 85/86 Dollars

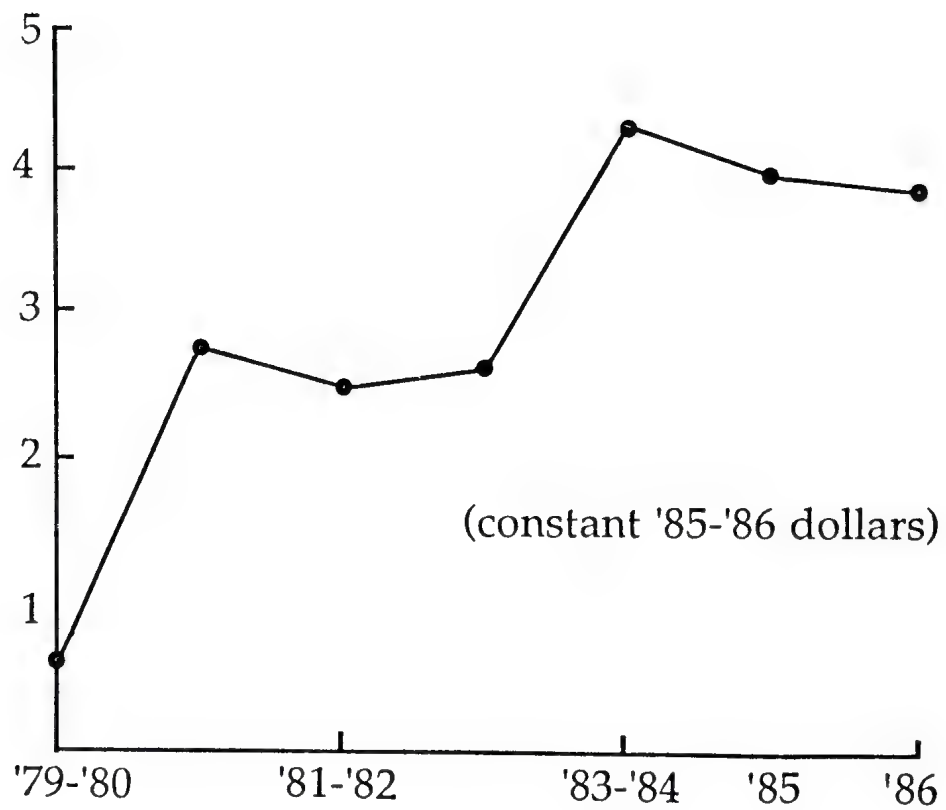
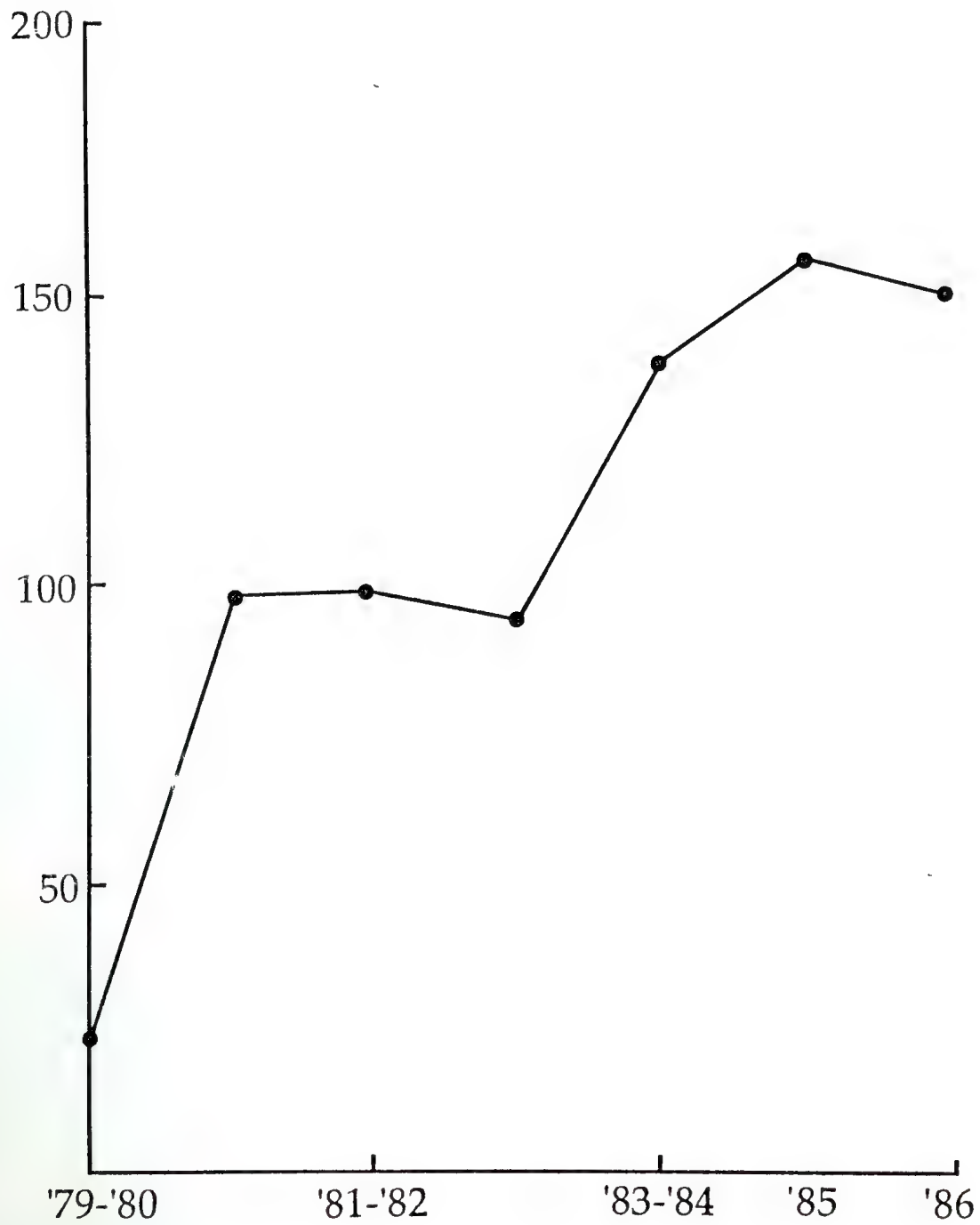


FIGURE 3

## NUMBER OF MSTGS GRANTS AWARDED EACH YEAR



Over the seven years that MSTGS was in existence, it distributed its funds over a range of scientific disciplines including physical oceanography, coastal engineering, geosciences, marine biology, environmental sciences, and other or multi-disciplinary projects (Figure 5). Marine biology dominated, having received 36% of MSTGS funding. Coastal engineering was the least funded category with only 6 percent of the total. However, these statistics more correctly reflect the problem of small numbers of coastal engineering applications received than any suggestion of bias on the part of the Committee.<sup>131</sup>

Up until 1984, when geographical priorities were eliminated from the grants assessment process, AMSTAC had advised MSTGS to consider the Great Barrier Reef, Bass Strait, and the North-west Shelf as regions of high priority for research. The imposed emphasis had a marked effect. The Great Barrier Reef alone has been the area where half of all MSTGS research funding was committed up to 1986. However, this emphasis, initially mandated by Government to be not less than 75 percent of the total funding available in 1979, consistently declined over the years as shown in Figure 6. Whereas the GBR received 76 percent of the total available MSTGS funds in 1979/80, the percentage had dropped to 34 percent in 1986. In this time projects in the 'Other or Multiple Regions' category progressively increased, totalling 50 percent in 1985 and 52 percent in 1986.<sup>132</sup>

Universities were the primary recipients of MSTGS funding receiving 77 percent of the overall MSTGS dollar (Figure 7). Commonwealth agencies (primarily CSIRO) have had decreasing MSTGS support since 1979. State Government agencies and museums have sought and received consistent if modest levels of support for marine research. Private firms have received only one percent of the total MSTGS funding since 1979.<sup>133</sup>

Table 5 indicates the institutions that received more than \$100,000 in grant money from MSTGS in 1986. (Total grants requested in 1986 were valued at 8.5 million dollars, yet the MSTGS was able to award only 3.8 million dollars in 1986.) Of these eleven all but two were universities. Those receiving the greatest sums were the James Cook University of North Queensland (\$780,000), the University of Sydney (\$520,000), the University of Western Australia (\$381,000), the University of Melbourne (\$268,000) and the University of Queensland (\$264,401). Significantly each of these universities except the University of Melbourne owns and operates a marine research facility off Australia's coastline.<sup>134</sup> In all, there were eighteen universities that received MSTGS funding in 1986.<sup>135</sup>

The 1987 Government budgetary constraints led to a 20 percent reduction in total funds available for MSTGS funding (to \$3.052 million). MRAAC protested to the Minister for Science that the cuts endangered the demonstrable benefits of Australia's seven year investment in the marine sciences - the established marine research programs; the developing marine industries such as mariculture, tourism, fisheries, and offshore mining; employment opportunities to marine researchers; the quality of long term projects already supported by MSTGS, and the attendant international respect.<sup>136</sup> Nevertheless the cuts were made.

Despite its status and high visibility in the scientific community, MSTGS has represented only a small portion of Australia's commitment to marine scientific research. On average it has received for distribution just seven percent (7%) of total Commonwealth expenditure in the non-defence related marine sciences.



FIGURE 4

AVERAGE FUNDING FOR INDIVIDUAL GRANTS  
BY YEAR

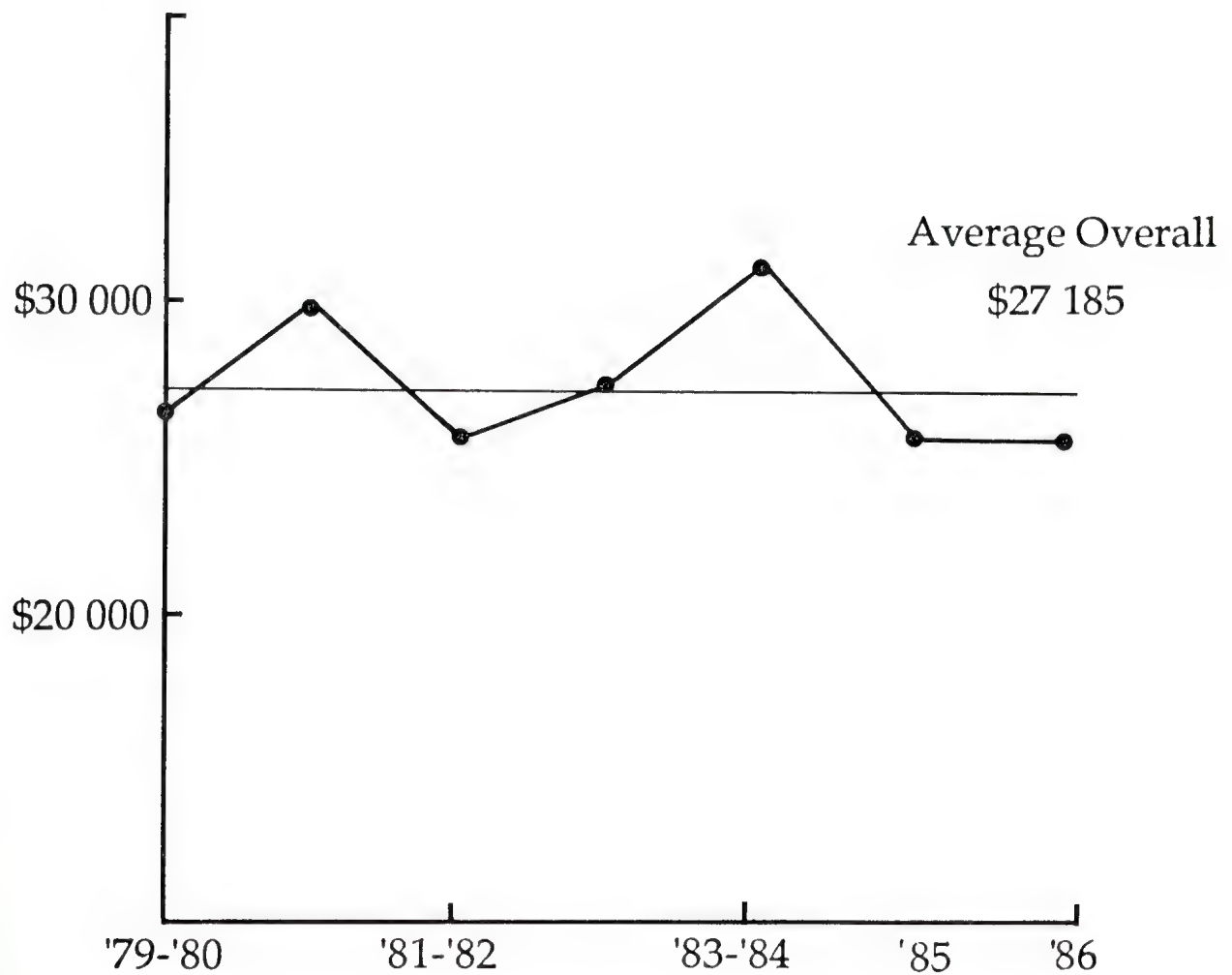
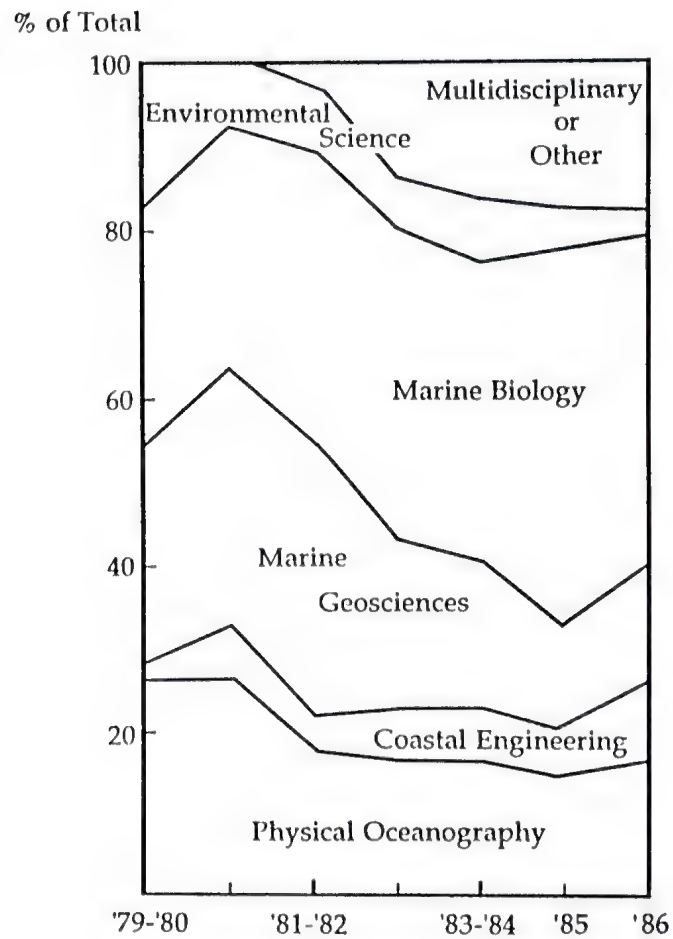


FIGURE 5

# PERCENTAGE OF MSTGS FUNDS BY DISCIPLINE AND YEAR



Overall Percentage

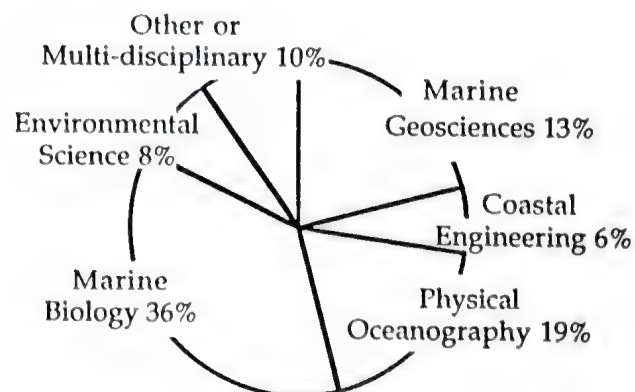
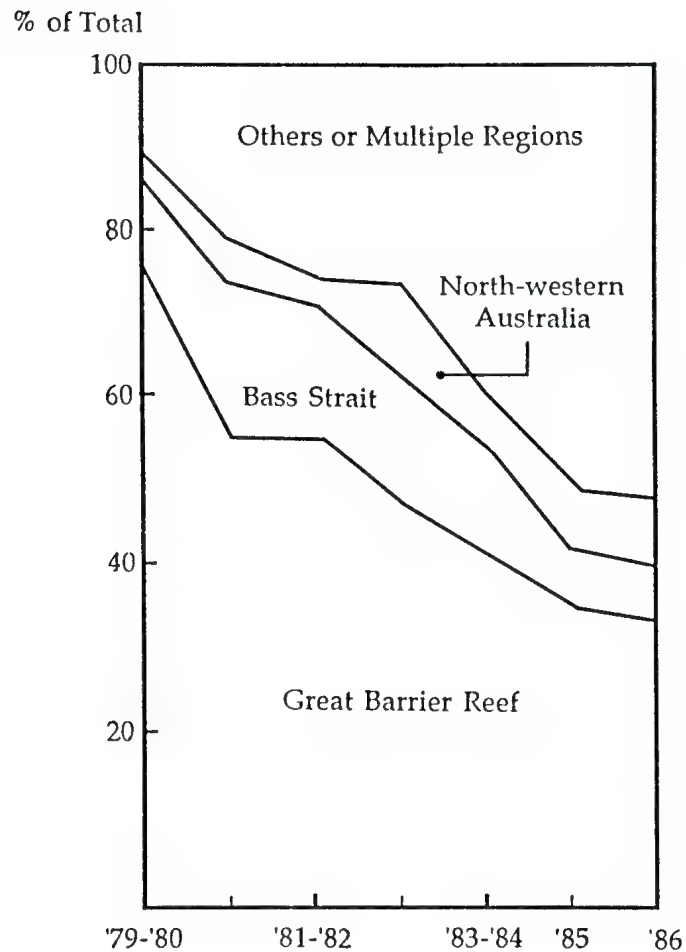
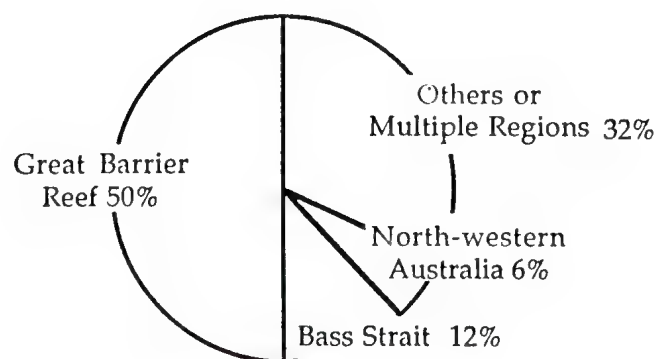


FIGURE 6

PERCENTAGE OF MSTGS FUNDS  
BY REGION AND YEAR



Overall Percentage





## 2. Other Funding Schemes

(a) Australian Research Grants Scheme (ARGS). In 1976, after having specially assigned nearly one million dollars to the marine sciences in the previous triennium, the ARGS determined that the standard of marine scientific research was of sufficiently high calibre to make unnecessary its status as a special area of research. In consequence marine scientists have been competing with all other sciences in Australia for research funding under this program. The Committee's research policy is to support basic non-directed research on the basis of excellence only. Since 1976 the marine sciences have competed for funding but the overall percentage of funding is modest relative to the spectrum of ARGS-funded research. For example, in 1986 the marine sciences received \$550,000 dollars from ARGS, just two percent of the total ARGS expenditure.<sup>137</sup>

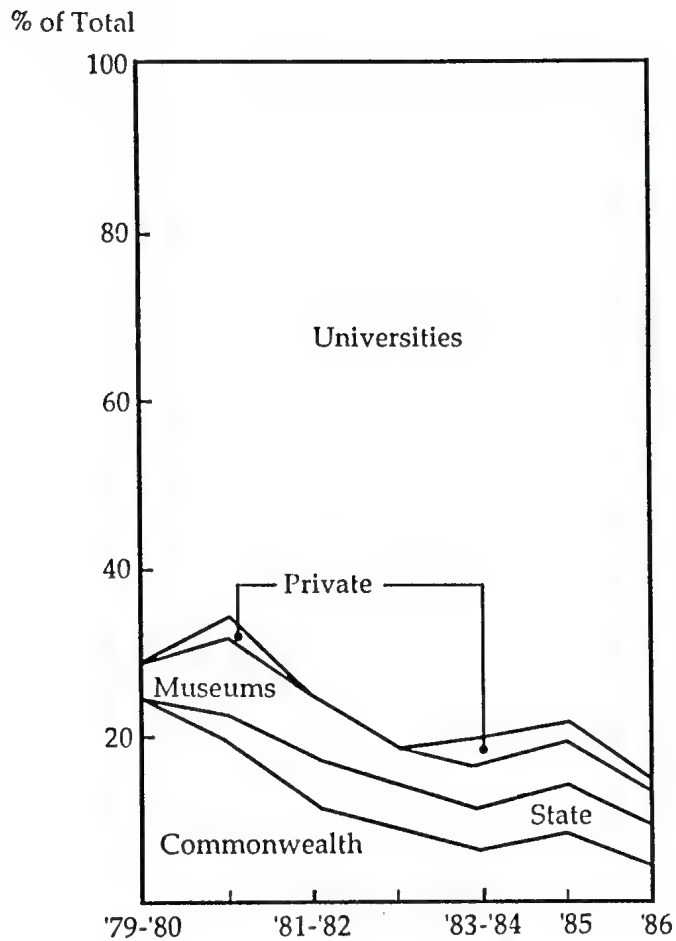
(b) Fishing Industry Research Trust Account (FIRTA). Applications for project funding are considered by the Fishing Industry Research and Development Council (FIRDC, previously the Fishing Industry Research Committee) whose members come from State fisheries departments, the fishing industry, CSIRO and the Australian Fisheries Service (DPI). FIRDC is responsible for setting national objectives, priorities and criteria for allocating Commonwealth funds for research in fisheries. Research areas include basic scientific and biological studies, but also studies on economics and management, marketing and product development, gear technology, and training and education.<sup>138</sup> The actual grants are administered by the Commonwealth Department of Primary Industries and Energy. Funds are contributed by the Commonwealth Government to match those raised by the States from the fishing industry. Recipients of FIRTA grants include researchers from universities, State agencies and CSIRO.<sup>139</sup>

(c) National Research Fellowships. In 1970 the Government established the Queen's Fellowships in Marine Science program to attract applications from marine scientists worldwide for postdoctoral work. Its administration was taken over by the MSTGS in 1981 and then four years later it was again transferred and subsumed by the National Research Fellowships Scheme. There is no longer a sole emphasis on the marine sciences but the topic is one of several indicated areas of priority. Now called the National Research Fellowships - Queen Elizabeth II Awards, the Scheme makes fifteen awards annually to individuals for research in priority areas of national interest, industry-based research, or fundamental research. Two of the fifteen fellowships awarded in 1986 were in the marine sciences.<sup>140</sup>

3. **Marine Science Funding for Commonwealth Agencies.** While it is a relatively easy matter to trace the individual grants awarded for marine science research in Australia, the accurate portrayal and comparison of funds spent by agencies on marine scientific research is much more difficult. Each has its own accounting system and interpretation of what constitutes money spent directly on research. The main problem for financial analysis lies in the substantial administrative costs that go into maintaining a research facility. MS&T grants may be used solely for research since a researcher's overhead costs are normally absorbed by his or her host institution. Those overhead costs remain hidden, that is, they have not been included in the Commonwealth's figures on money spent on marine research in Australia. In contrast, the research budgets at institutions such as AIMS, BMR and CSIRO may include substantial overhead costs associated with maintaining the facilities, equipment and staff. Thus any comparison between "research dollars" spent by the major agencies and by Universities must be approached with these differences in mind.

FIGURE 7

# PERCENTAGE OF MSTGS FUNDS BY TYPE OF INSTITUTION



Overall Percentage

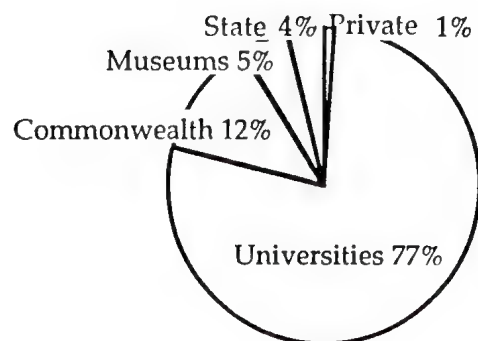


TABLE 5

## MAJOR RECIPIENTS OF MS&amp;T GRANTS IN 1986

Institution	Total Funds Awarded	Percentage of Total
James Cook University	\$781,226	20%
University of Sydney	\$519,825	14%
University of Western Australia	\$380,932	10%
University of Melbourne	\$267,660	7%
University of Queensland	\$264,401	7%
CSIRO	\$198,191	5%
University of New South Wales	\$194,594	5%
Griffith University	\$144,353	4%
Monash University	\$137,760	4%
Flinders University	\$136,564	4%
Australian Museum	\$122,550	3%
All Others	\$678,944	17%
<b>Total</b>	<b>\$3,827,000</b>	<b>100%</b>



The major Commonwealth agencies that conduct, or distribute funds for the conduct of, marine scientific research (excluding Defence) include CSIRO, AIMS, BMR, the Department of Primary Industries and Energy, the Great Barrier Reef Marine Park Authority (GBRMPA), and the Antarctic Division. Table 6 provides a breakdown by year on the total funds allotted each year since 1979. Figure 8 shows how agency budgets compare on a percentage basis.

The overall distribution of research dollars by area of research interest reveals a strong bias towards marine biology. (Table 7, Figure 9) Each agency routinely supports some level of marine biological research except BMR, which focuses strictly on marine geoscience. Consistent with the nature of the era in which it was born, AIMS has been largely responsible for the funds spent on ecological marine science.<sup>141</sup>

Support for coastal and ocean engineering is conspicuously at a negligible level.<sup>142</sup>

(a) **CSIRO.** Despite a relatively small absolute amount of dollars that CSIRO assigns to its marine research activities, this amount nevertheless represents the largest single allocation in Australia's marine research funding. The Divisions of Fisheries and of Oceanography together accounted for roughly 36% of all the marine research money spent in Australia in 1985/86. During the years 82/83 and 83/84 when the Divisions moved to Hobart from Cronulla and when the R/V Franklin was purchased, CSIRO accounted for nearly 60% of the marine scientific research funds.

Research programs at the Division of Fisheries Research

"are primarily directed towards the solution of economic problems. The objectives of the work are to maintain, develop and improve the fisheries, with particular reference to the rational exploitation of the resource and the interests of the catching sector, and the quality and value of the product."<sup>143</sup>

The seven research programmes include - algal physiology and ecology, biological oceanography, fisheries resources, fish population dynamics and stock assessment, prawn biology, coastal ecology and western rock lobster, and seafood technology.

As Australia's principal deep-water oceanographic research facility, CSIRO's Division of Oceanography conducts physical and chemical oceanographic research throughout the Australian marine region. Recent research initiatives have studied the west equatorial Pacific Ocean, the Leeuwin Current, the Antarctic convergence, and the Coral and Tasman Seas. The Division has an active role in the international Tropical Ocean Global Atmosphere (TOGA) experiment that studies the interrelation between the dynamics of the tropical ocean and world climate variability. It is otherwise committed to enhancing its capability in marine instrumentation, conducting basic research on the processes of mixing and on other continental shelf and boundary current dynamics. Research that is applicable to the maritime industries involves wave climate studies, regional modelling, and search and rescue strategies.<sup>144</sup>

TABLE 6

**EXPENDITURE OF COMMONWEALTH FUNDS  
ON CIVIL MARINE SCIENCE RESEARCH AND DEVELOPMENT\***

(\$ millions)

	79/80	80/81	81/82	82/83	83/84	84/85	85/86
Antarctic Division	.44	2.29	2.45	2.94	3.11	4.16	4.42
AIMS	3.58	5.22	5.76	6.54	7.02	7.50	7.78
BMR	1.32	1.52	2.94	2.18	4.30	8.28	8.15
CSIRO							
Fisheries	6.23	6.87	9.95	11.67	18.47	8.97	9.06
Oceanography	2.39	2.59	4.72	10.92	9.27	7.43	7.43
DPI Fisheries	.56	.60	.64	.94	1.99	4.36	4.60
GBRMPA**	.08	.08	.11	.20	.27	.39	.75
MST	.39	2.00	1.90	2.12	3.76	3.83	3.83
Queens Fellowships	.25	.25	.34	.26	.27	-	-
<b>TOTAL</b>							
Actual \$	15.24	21.42	28.82	37.77	48.46	44.92	46.02
Constant 85/86 \$	24.38	31.32	37.75	45.32	54.76	46.27	46.02

\*Primary Source - AMSTAC Secretariat, Canberra ACT, 1987

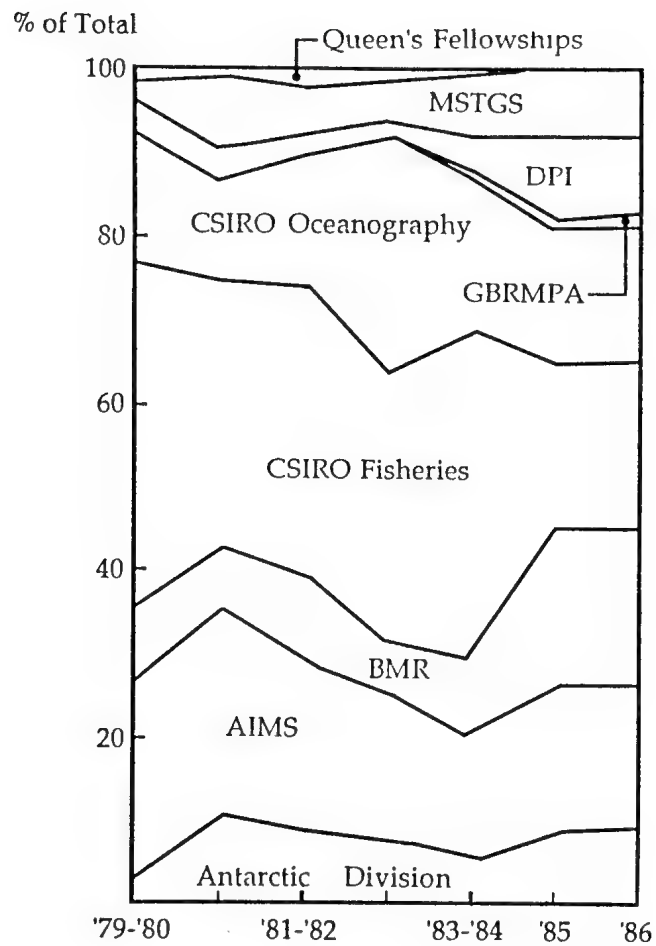
\*\*These figures are not those provided by AMSTAC but are instead a reflection of the co-author's (M. Watson) analysis of GBRMPA's research expenditure. The figures in this table includes only funding spent by GBRMPA on the marine sciences and do not include money GBRMPA has spent in support of socio-economic research in the Marine Park. (Technical report to be produced by GBRMPA in 1988.)

Notes by AMSTAC -

1. The table includes information from the S & T Statement database plus information supplied by BMR and CSIRO. It does not include those components of general university funding which go to support marine science research.
2. ARGs expenditure on marine science R & D is not included. It was estimated by ASTEC (S&T in Australia 1977-78) that ARGs support was less than \$.07 million at that time. The funding from ARGs for marine science programs has decreased as applicants have applied for MS&T grants introduced in 1979/80.
3. The CSIRO figures include only expenditure of Commonwealth funds allocated directly to CSIRO (excludes DPI trust funds).
4. BMR figures include some work which is not regarded as R&D."

FIGURE 8

# PERCENTAGE BREAKDOWN OF COMMONWEALTH FUNDING FOR MARINE SCIENTIFIC RESEARCH BY AGENCY AND YEAR



Overall Percentage

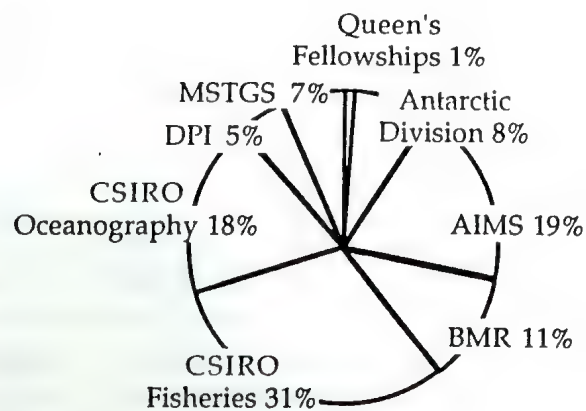




TABLE 7

**COMMONWEALTH FUNDS FOR CIVIL MARINE SCIENCE  
RESEARCH AND DEVELOPMENT BY RESEARCH AREA  
(\$ millions)**

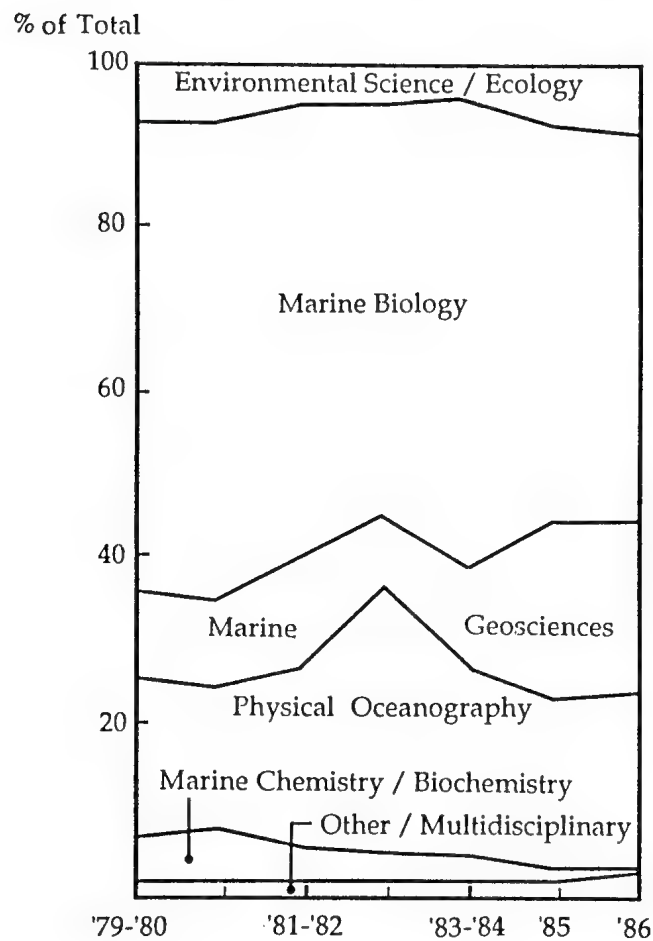
	79/80	80/81	81/82	82/83	83/84	84/85	84/86
<b>Env'l Science Ecology</b>							
AIMS	.97	1.28	1.47	1.61	1.80	3.03	3.38
MS&T Grants	.07	.16	.15	.13	.26	.18	.12
<b>TOTAL</b>	<b>1.04</b>	<b>1.44</b>	<b>1.62</b>	<b>1.74</b>	<b>2.06</b>	<b>3.21</b>	<b>3.50</b>
<b>Marine Biology</b>							
Antarctic	.44	2.29	2.46	2.94	3.11	4.16	4.42
AIMS	1.15	2.05	2.09	2.25	2.20	2.00	1.84
CSIRO	6.23	6.87	9.95	11.67	18.47	8.97	9.06
DPI	.56	.60	.64	.94	1.99	4.36	4.60
GBRMPA	.08	.05	.03	.16	.19	.29	.36
MS&T Grants	.11	.54	.66	.79	1.36	1.72	1.54
<b>TOTAL</b>	<b>8.57</b>	<b>12.40</b>	<b>15.83</b>	<b>18.75</b>	<b>27.32</b>	<b>21.50</b>	<b>21.82</b>
<b>Marine Geoscience</b>							
AIMS	.17	-	-	.64	.73	.67	.61
BMR	1.32	1.52	2.94	2.18	4.30	8.28	8.15
GBRMPA	-	-	.01	-	.04	.03	.07
MS&T Grants	.10	.58	.62	.42	.63	.42	.49
<b>TOTAL</b>	<b>1.59</b>	<b>2.10</b>	<b>3.67</b>	<b>3.24</b>	<b>5.70</b>	<b>9.40</b>	<b>9.32</b>
<b>Physical Oceanography</b>							
AIMS	.45	.61	1.01	.74	.83	.77	1.33
CSIRO	2.39	2.59	4.72	10.92	9.27	7.43	7.43
GBRMPA	-	.02	.03	.03	.01	.06	.05
MS&T Grants	.10	.49	.33	.35	.66	.57	.66
<b>TOTAL</b>	<b>2.94</b>	<b>3.71</b>	<b>6.09</b>	<b>12.04</b>	<b>10.77</b>	<b>8.83</b>	<b>9.47</b>
<b>Marine Chemistry/Biochemistry</b>							
AIMS	.83	1.28	1.19	1.29	1.45	1.04	.61
GBRMPA	-	-	-	-	.01	-	-
<b>TOTAL</b>	<b>.83</b>	<b>1.28</b>	<b>1.19</b>	<b>1.29</b>	<b>1.46</b>	<b>1.04</b>	<b>.61</b>
<b>Other/Multi-Disciplinary</b>							
GBRMPA	-	.01	.04	.02	.02	.02	.27
MS&T Grants*	-	-	.07	.30	.64	.69	.69
Queens F'ships	.25	.38	.52	.70	1.17	.96	1.28
<b>GRAND TOTALS</b>	<b>15.22</b>	<b>21.31</b>	<b>28.92</b>	<b>37.76</b>	<b>48.48</b>	<b>44.94</b>	<b>46.00</b>

Sources: AIMS - Personal interview and documents of AIMS' Director (co-author J.T. Baker) and Finance Officer (V. Meara)  
 Antarctic Division - Personal telephone contact, Patrick Quilty, 29 October 1987  
 GBRMPA - Annual Reports and archives at GBRMPA  
 All Other Agencies - AMSTAC Secretariat, October 1987

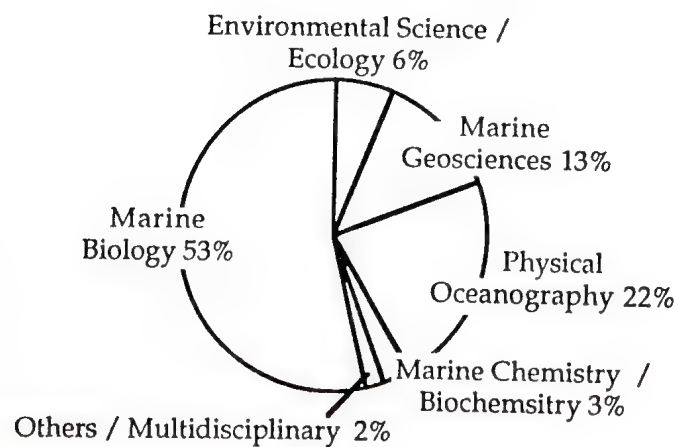
\*Includes funding for coastal engineering.

FIGURE 9

**PERCENTAGE OF COMMONWEALTH FUNDS EXPENDED  
FOR CIVIL MARINE SCIENCE RESEARCH AND DEVELOPMENT  
BY RESEARCH AREA AND YEAR**



Overall Percentage



(b) **AIMS.** In recent years AIMS has drawn roughly one sixth of the Australian Government's total marine research funding, excluding marine defence expenditure. Concentrating on Australia's tropical waters, AIMS' principal research programs cover Coastal Processes and Resources, Reef Studies, Environmental Studies and Marine Systems Analysis with special emphasis on mangroves, coral reef ecosystems, crown of thorns starfish, coastal and reef oceanography, and paleoenvironmental records in massive corals. With James Cook University and GBRMPA, AIMS has also developed a North East Australian Satellite Imagery Receiving Station for broad regional study. Other industry applications in 1987 included the identification and development for human use of substances in corals that absorb harmful ultra-violet light, collaboration with the National Cancer Institute of the United States to seek anti-cancer and anti-AIDS substances from marine organisms, prawn mariculture and the potential use of paleoenvironmental information for coastal and marine engineering project planning.<sup>145</sup>

(c) **BMR.** The object of the Bureau of Mineral Resources, Geology & Geophysics of the Department of Resources and Energy is "to conduct mission oriented research in frontier areas and under-explored areas, directed at elucidating the structure, stratigraphy and evolution of Australia's continental margins, plateaus and adjacent ocean basins" toward hydrocarbon and mineral resource evaluation and assessment and the development of "globally applicable models of margin development".<sup>146</sup>

In the early 1980s, BMR had concentrated its research in the Bass and Gippsland Basins toward the discovery of hydrocarbon reserves. Prior to this time, in 1976 and until the early 1980s, the Great Barrier Reef had been identified as a priority research area, not to pursue hydrocarbon reserves, but rather to gain understanding of the evolution of the Reef.<sup>147</sup>

In 1984 BMR commenced a new marine geoscience research program around the continental margin of Australia. To that effect the Government allocated funds for the charter of a research vessel, R/V Rigg Seismic, the provision of additional staff, purchase of marine seismic and sampling equipment and a Seismic Data Processing Centre for BMR. This major investment by the Government is reflected in BMR's doubled research budget from 1983/84 to 1984/85. (See Table 6, Figure 8.)

Among its major accomplishments in recent years, BMR highlights:

- recognition of new hydrocarbon clay deposits in the Bass Basin, leading to the Tolla gas/oil/condensate discovery in 1985;
- mapping, for the first time, the huge area of Australian jurisdiction around Heard Island, and the subsequent drilling on the Kerguelen Plateau;
- renewed interest in the exploration in the offshore Otway Basin;
- identification of new frontier exploration areas off northeastern and southern Australia;
- discovery of new mechanisms governing the formation of phosphorites on the shelf;
- identification of continental margin rift mechanisms; and
- identification of a new model describing the evolution of carbonate platforms.<sup>148</sup>



(d) **DPI.** Among its other fisheries management duties the Australian Fisheries Service of the Department of Primary Industries and Energy (DPI) is responsible for research and monitoring of fisheries resources.<sup>149</sup> The FIRTA funds constitute the major part of DPI's research expenditure. Increased fishing pressure in recent years has led to a growing conviction by the fishing industry and its representatives about the need for improved research and monitoring arrangements in the major fisheries.<sup>150</sup> There was an upsurge of funding for FIRTA in 1983/84 and subsequent years (Table 6).

In addition to FIRTA, money is allotted each year by DPI for research on Torres Strait fisheries that are jointly managed by Australia and Papua New Guinea.<sup>151</sup>

(e) **GBRMPA.** The function of the Great Barrier Reef Marine Park Authority allows it to conduct research in its own right and/or to commission research that is relevant to the Marine Park. Each year GBRMPA supports an array of research projects in its effort to increase knowledge and to capably manage the Great Barrier Reef Marine Park. Most research is conducted for the Authority by universities, private consultants, and government research bodies. The research GBRMPA supports addresses a range of issues including socio-economic questions, data base development, etc. Only marine scientific research in the areas of physical oceanography, marine chemistry, marine biology, marine geosciences, and bathymetry and survey were included in the tabulation for this report.

(f) **Antarctic Division.** The Antarctic Division has existed since 1947 but its research effort has included a full-fledged marine science component including a chartered research vessel only since 1979. It had long been a Division of the Department of Science but during the 1987 re-organisation was moved to the Department of Arts, Sport, Environment, Territories, and Tourism. The marine work of the Division focuses on Southern Ocean marine biology, supported by oceanographic work, and emphasises the study of marine phytoplankton, krill and seals.<sup>152</sup> Most of the research relates directly to existing international collaborative programs in support of the Convention for the Conservation of Antarctic Marine Living Resources.<sup>153</sup> The Division's budget is largely taken up by the high costs of providing logistic support for research activities in the Antarctic.

(g) **Other agencies.** Although Table 6 lists just nine major agencies or programs that receive Commonwealth funds for marine scientific and technological research, there are at least another nine that also conduct or support marine research to some degree. These agencies are - the Department of Arts, Sport, Environment, Territories, and Tourism; the Bureau of Flora and Fauna; the Australian National Parks and Wildlife Service; the Department of Housing and Construction; the Defence Science and Technology Organisation; the Royal Australian Navy; the Bureau of Meteorology; The Department of Transport; and the Division of National Mapping. Their funding levels for marine research were either too small or unavailable to be included in this report.

The Department of Arts, Sport, Environment, Territories, and Tourism (formerly the Dept. of Arts, Heritage and the Environment) is responsible under the Torres Strait Treaty for protecting the marine environment in the Torres Strait. It has established a monitoring program in those waters. This interest has spawned a broader commitment by the Department to further develop Australia's marine pollution monitoring program for nation-wide use.<sup>154</sup>

The Bureau of Flora and Fauna administers the Australian Biological Resources Study (ABRS) which regularly include projects in marine research although the nature of these projects varies from year to year and the overall proportion of marine research funding is small.

One of the functions of the Australian National Parks and Wildlife Service is to 'develop research, survey, inventory and monitoring programs for nature conservation activities of national significance'.<sup>155</sup> The Service contracts research consultants to obtain information about areas of interest for conservation and thus facilitates the establishment of marine and estuarine protected areas. The Service also supports research on marine mammals.<sup>156</sup>

The Department of Housing and Construction conducts site investigations, collects environmental data, and undertakes feasibility studies for proposed civil works in the coastal and offshore zones. It also conducts specialised studies on coastal and ocean engineering topics, develops technical standards and designs for coastal and offshore engineering works, and maintains a data bank on wave recording stations.<sup>157</sup>

The work of the Defence Science and Technology Organisation (DSTO) is not integrated with nor generally accessible to the civil sector due to the perceived need to guard sensitive information in the national interest. Its underwater acoustics and oceanography work includes Project Seemap, geoacoustics research, studies in military oceanography, the study of sediment transport for mine burial, and environmental acoustics research.<sup>158</sup>

The Royal Australian Navy's Marine Science Force is divided into the disciplines of hydrography, oceanography, and marine meteorology, being active in charting, data collection and exchange, and forecasting.<sup>159</sup>

The *Meteorology Act 1955* legislated the functions of the Bureau of Meteorology to include - "the promotion of the advancement of meteorological science, by means of meteorological research and investigation...".<sup>160</sup> The Bureau has a longstanding marine observation and monitoring program and its research efforts include regional analysis and prediction and ocean-atmosphere coupling.<sup>161</sup> Budgetary information between the years 1979-1986 is not complete, but the Bureau is listed by AMSTAC as having devoted \$500,000 in 1983/84 and \$418,000 in 1984/85 for research on marine sciences and technologies.<sup>162</sup>

As part of its responsibility for coordinating the National Plan to combat marine oil pollution, the Department of Transport has instituted an oil dispersant test program. Recent tests aimed to extend and validate results of laboratory testing, assess the effectiveness of aerial spraying systems on oil spills at sea, and investigate the usefulness of remote sensing techniques to detect oil spills.<sup>163</sup>

Finally, the Division of National Mapping, since 1971, has been conducting a bathymetric survey of the continental shelf of Australia and its Territories. This continues to be an awesome task that is far from complete.



AMSTAC summarised its 1986 Coordination Workshop by once again lamenting the lack of coordination between research bodies.

"...there are still substantial gaps to be filled if Australia is to have a comprehensive marine science and technology program....the existing program is not yet sufficiently well coordinated. Agencies are actively seeking cooperation where possible but the funding levels are marginal for most agencies and the effort expended in coordination often has to come out of core programs. International interactions were especially restricted by the shortage of specific funds."<sup>164</sup>

## F. In Pursuit of a National Marine Policy

The 1982 Labor Party Platform addressed the marine sciences specifically. It avowed to -

"Pursue comprehensive knowledge of the oceans of the 200 nautical mile 'exclusive economic zone' (EEZ) surrounding Australia.

Replace the Australian Marine Sciences and Technologies Advisory Committee (AMSTAC) with an Australian Marine Science Council and expand its Terms of Reference to recommending national policies.

Expand the functions of CSIRO's Division of Oceanography and the Australian Institute of Marine Science."<sup>165</sup>

By July 1982, the Marine Policy Branch (established in 1979) of the Department of Science had written a paper entitled "Towards a Commonwealth Policy for Marine Science and Technology".<sup>166</sup> In it the Department (1) stressed the Commonwealth Government's responsibility for its offshore areas and territorial seas, and (2) defined its own authority and role as an initiator, reviewer and coordinator of marine policy in the light of the pressing need for a more effective national marine R&D effort.

AMSTAC, in response, took exception to the Department's attempt to independently address issues of such broad scope and intent. No effort had been made to review the role of other relevant Commonwealth agencies nor to suggest how the Department would go about providing coordination in the marine science community. Meetings were called in light of the "fundamental differences in approach" between the Department and AMSTAC for discussion on the best way to organise marine policy development.<sup>167</sup> Both CSIRO and AIMS also voiced concerns along similar lines.<sup>168</sup>

During the course of discussion a compromise was struck. AMSTAC and the Department of Science agreed to collaborate in a review of marine science and technology policy. The deliberations continued throughout 1983 to formulate a new document that would -

- (1) "seek to establish the role of the Commonwealth Government in the national program and to identify those activities which would be the primary focus for the ensuing 5-10 years", and



- (2) "address the appropriateness of existing institutional arrangements and support mechanisms to meeting the role and activities in Part 1. Specifically this part would address the questions of an Australian Marine Science Council and the future role of AIMS, both highlighted in the ALP Platform."<sup>169</sup>

But sentiments changed at some point.

No action was ever taken in response to the joint AMSTAC/Department of Science plans. Instead there was a progressive weakening of the Government's emphasis on marine science. Before the year was out the Marine Policy Branch of the Department of Science had been incorporated into a large Sectoral Policy Branch of the Department which had responsibility for biotechnology along with marine science. Then in 1985 the Sectoral Policy Branch was given responsibility for 'scientific development'. The marine science focus was further weakened in 1986 when more administrative changes occurred in the Department.

The 1986 Labor Party Platform statement about marine science, modified from that of 1982 and 1984, made no reference to the formation of an Australian Marine Science Council. The Government had indicated that it preferred to use existing organisations rather than create new bodies.

Meanwhile, AMSTAC persevered. However, the document it submitted to Government in June 1984 also said nothing about an Australian Marine Science Council. Instead a more general approach was adopted that focussed on issues, rather than the administration, of marine science and technology in Australia. The paper outlined seven major objectives for Australian Government action in the coming decade:

- (1) Establish a permanent national network of marine data-gathering facilities, and a program to acquire and collate basic physical, chemical and biological data on the marine environment.
- (2) Upgrade Australia's capability for research, design and testing in coastal and ocean engineering by developing existing laboratories and expertise to a level sufficient to meet our needs.
- (3) Establish a basic understanding of the petroleum potential of the sedimentary basins on Australia's continental margins, with particular emphasis on its north-western waters.
- (4) Establish mechanisms to encourage the development of marine technologies in Australian industry.
- (5) Elucidate the basic processes characterising and driving the major ocean/atmosphere systems surrounding Australia in order to improve the lead-time and accuracy of weather forecasts, and aid the development of climate prediction.
- (6) Undertake the research needed to manage fisheries of national importance and fisheries to which other countries have been given access in accordance with Australia's international obligations.

- (7) Establish an effective mechanism for Federal/State co-operation to maintain, develop and extend Australia's taxonomic collections of marine plants and animals.<sup>170</sup>

Presented in the context of a broad marine policy statement, these seven objectives are consistent with the marine science and technology recommendations that AMSTAC has made to Government over the years.

Yet again the message fell flat. ASTEC, in its comments to the Prime Minister about the AMSTAC paper, advised - "A statement that raised undue expectations about future levels of funding or program development ... might well be counter productive ...."<sup>171</sup> AMSTAC was also criticised for not having sufficiently acknowledged the existing difficulties nor emphasising the need for every sector and agency involved in marine science and technology to work together.<sup>172</sup> No response was ever made by the Government to AMSTAC about the adoption of an Australian marine science and technology policy.

In contrast, the marine science community did respond. The Minister for Science, Barry Jones, had written to Ministers and Government departments seeking comment on the proposed policy paper and expressing his intent to "seek Cabinet endorsement of the statement as an expression of policy intent."<sup>173</sup> While the vast majority of those who responded applauded the concept of adopting an Australian marine, science and technology policy, AMSTAC attracted the same criticisms that had been levelled at the Department of Science two years earlier - for not having adequately involved the larger marine science community in producing such a statement and so not adequately representing the sentiments that others would have liked to see expressed. The enduring lack of coordination and communication in marine science had become a vicious circle.

... and so the dilemma persists.





## V. WHAT IS THE FUTURE FOR AUSTRALIAN MARINE SCIENCE AND TECHNOLOGY?

Among a society's possible motivations for doing research are curiosity, national pride, social need, strategic planning, exploration of new areas of potential importance, the creation of new markets and protection of existing markets.<sup>174</sup> The potential benefits may be knowledge, prestige, social improvement, and economic returns in the longer or shorter term.

During the heightened international and environmental awareness of the 1970s, Australia was highly motivated to pursue knowledge, prestige and social improvement through the development of its marine scientific research effort. The kind of marine science that the Government enthusiastically supported reflected that mood. AIMS was built in order to become an international centre of excellence, to open new frontiers of study, and to exhibit to the world Australia's commitment to its marine resources. Other significant national initiatives, such as the *Great Barrier Reef Marine Park (GBRMP) Act 1975* and the *Australian Heritage Commission Act 1975* had similar goals.

In the 1980s a transition has taken place which has great significance for the entire marine science community.<sup>175</sup> The transition in Government attitude from an emphasis on the pursuit of knowledge to an emphasis on measurable economic returns was given concrete effect in July 1987. During the Commonwealth Government re-organisation, the Department of Science was abolished and its responsibilities dispersed among four Departments. AIMS and CSIRO were transferred to the Department of Industry, Technology and Commerce. The Marine Sciences and Technologies Grants Scheme, previously a highly visible mechanism to make possible the conduct of an essential portion of Australia's marine science and technology activity, was split from AMSTAC and subsumed by the Australian Research Council, a new funding program for research within the Department of Education, Employment and Training.<sup>176</sup> AMSTAC's fate remained uncertain in 1988.

As part of the Ministry of Industry, Technology and Commerce, the marine science agencies will be assessed and funded, at least partly, on the basis of their potential and actual contribution to the Australian economy. Although the range and potential of marine science applications are vast (Table 1), the argument for financial investment, defies short-term cost/benefit analyses. The costs of conducting marine scientific research are easily tallied in the short run but its benefits are long term and have a wide range of application. The authors of the *IOC/UNESCO Ocean Science for the Year 2000* report -

"While the justification stressed here for increased priority [for marine science] is focused on application, much of the necessary research is of a fundamental character. There is a broad spectrum of kinds of research, from the most fundamental with widespread relevance but no obvious short-term application to the most applied with immediate application but little relevance to other problems. The time-scale of payoffs varies greatly over the spectrum, and it is commonly difficult to predict just when the application of findings will become feasible. It is important to recognize that applied research draws upon the reservoir of scientific knowledge, and it is often the case that problems of immediate concern cannot be solved without additional research of a very fundamental character."<sup>177</sup>

In its 1986 *Reviews of National Science and Technology Policy: AUSTRALIA*, the Organisation for Economic Co-operation and Development (OECD) arrived at conclusions that seem particularly relevant to the current situation in Australian marine science:

"Australia needs a common understanding of what science and technology can be expected to do for the country and for industry. This requires understanding of the stages of research and technical development - and also of how different organisations proceed (or fail to proceed) from one stage to the next."<sup>178</sup>

The levels of the scientific and technical process, as outlined by OECD, are (1) 'experimental' scientific research, (2) basic research that is driven by curiosity, (3) basic research that is policy-driven, (4) applied research, (5) engineering and product design, (6) production, and (7) marketing, service and follow-up.

The report continued -

"The progress between two levels often involves a cultural collision of different kinds of people....We found in Australia - perhaps more than in some other OECD countries - a rather narrow view of these roles. At the first 2-3 levels, i.e. within the scientific community, many (but not all) seem to think that science is best directed and judged, and certainly best understood, by scientists and scientists alone. At the next levels, i.e. in industry, some spoke of the scientific community as "only interested in publishing papers". Both seemed to disdain politicians and administrators, while expecting them to provide more funds and direction, at the same time as fewer taxes and less interference. Some administrators, by contrast, seemed to have an attitude towards industry characterized by broad generalizations and little knowledge of specifics."<sup>179</sup>

At the very least, these attitudes contribute to the lack of understanding and agreement between the principal parties and they may even be blamed for the enduring impasse between marine science policy advisors and the politicians.

To quote again from the OECD - "Australia now possesses a sizeable scientific and technological potential, in terms of both institutional diversification and resources. It remains for the Government and society to clarify the major goals to be assigned to this effort."<sup>180</sup>

The marine scientific community and the Government must work together to identify and achieve their mutual goals. The opportunity exists to expand the role and contributions of marine science in Australia. The Government must be fully informed about the realisable objectives in marine science and technology research in order to assign priorities for the development of Australia's vast area of marine responsibility.

The responsibility for providing pertinent information to Government may now lie in the hands of the agencies of Government themselves and the Universities, because the specific marine science and technology advisory and granting committees have been reduced in influence or have disappeared altogether.



## SOURCES AND EXPLANATORY NOTES

1. As per the United Nations Convention on the Law of the Sea. See G.F. Humphrey, "UNCLOS and the Marine Scientist", *Marine Policy*, July 1981, pp.270-271.
2. The *Endeavour's* voyage and others are reviewed in Sir Maurice Yonge's historical analysis of events in the world of marine science that led to Great Britain's sponsorship of the Challenger expedition. "The Inception and Significance of the Challenger Expedition", *Proc. R.S.E. (B)*, Vol. 72, 1971/72.
3. The work of these scientists is described in:
  - Ian S.Jones and J.E.Jones, "Early 19th Century Oceanography around Terra Australis" in *Oceanography: The Past*, Proceedings of the Third International Congress on the History of Oceanography, 22-26 September 1980, M.Sears and D.Merriman (eds), New York: Springer-Verlag, 1980, pp. 448-461
  - S.J. Edmonds, "Zoology" in *Ideas and Endeavours - The Natural Sciences in South Australia*, Royal Society of S.A. (pub), 1986, p.161-212.
4. Speech by Professor H.C.Richards "Problems of the Great Barrier Reef" (reproduced in *Queensland Geographic Journal*, Vol.36/37, 1922, pp. 42-54) given to the Royal Geographical Society of Australasia, Queensland in April 1922.
5. For a history of the lengthy controversy over the origin of the Great Barrier Reef and coral reefs in general see:
  - C. Maurice Yonge's "The Royal Society and the Study of Coral Reefs" in *Oceanography: The Past*, Proceedings of the Third International Congress on the History of Oceanography, 22-26 September 1980, M.Sears and D.Merriman (eds), New York: Springer-Verlag, 1980, p.438-447.
  - A. Agassiz "A visit to the Great Barrier Reef of Australia" *Bulletin of the Museum of Comparative Zoology*, Vol.28, 1898, pp.95-148.
  - W.M. Davis *The Coral Reef Problem*, New York: American Geographical Society Special Publication No.9, 1928 (especially Chapter XIII "Embayed, Non-Cliffed Islands with Barrier Reefs", Subsection 'The Great Barrier Reef of Australia', p.345-363
  - Gardiner and Crossland, *Coral Reef Papers*, 1898-1939 (Sir Maurice Yonge Collection, AIMS, MY70941)
6. Saville-Kent, W. *The Great Barrier Reef of Australia; Its Products and Potentialities*, London, 1893 (Melbourne, John Currey, O'Neil Pty. Ltd. 1972).
7. A.J.Harrison, A/Deputy Director, Department of Sea Fisheries Tasmania wrote of Saville-Kent - "The story of his appointment, innovations, and resignation after conflict with the Salmon Commissioners is a fascinating episode in public administration." (unpublished Project Outline, 'Will Better Bait Land More Fish? - The History of Fisheries Development in Tasmania', 1987)



8. Dannevig is credited by J.M.Thomson in his paper "Marine Science and Government" (AMSA Bulletin No.50, April 1975, pp 3) as the first "major figure in marine research in Australia". He was in any case the first to be employed outright on a long term basis by the Australian Government to conduct marine research.
9. Dr. D. Griffin, Australian Museum, 'Australian Museum Marine Science History', personal correspondence to Dr. Joe Baker, 8 February 1988.
10. For a brief history of the Australian reef research prior to 1964 see P.Mather and F.H. Talbot's "Research Facilities in the Great Barrier Reef - Their History, Operation and Funding", *Search*, Vol.6, No.8, August 1975, p.336.
11. For detailed accounts of the history of the Great Barrier Reef Committee, see :
  - Hill, Dorothy. "The Great Barrier Reef Committee, 1922-1982: The first thirty years", *Historical Records of Australian Science*, Vol.6, No.1, 1984. pp. 1-18.
  - by the same author "The Great Barrier Reef Committee, 1922-1982, Part II: The Last Three Decades" *Historical Records of Australian Science*, Vol.6, No.2, December 1985. pp. 195-221.
  - Jones, O.A. "The Great Barrier Reef Committee 1922-1973" in *Proceedings of the Second International Coral Reef Symposium*, Brisbane: Great Barrier Reef Committee, December 1974, pp. 733-737.
12. Although the University of Western Australia was active in marine biological research at this time, it is excepted in this list of contributors to the Committee. It is doubtful that it was even contacted by the Committee at that time.
13. Jones, O.A. "The Great Barrier Reef Committee 1922-1973", *Proceedings of the Second International Coral Reef Symposium*, GBRC:Brisbane, December 1974, p.733.
14. Hill, Vol.6, No.1. 1984, pp. 5-8.
15. Professor F.W. Whitehouse organised the expedition in August 1954 that resulted in a number of relevant publications including:
  - W. Stephenson and J.W. Wells "The Corals of Low Is. Queensland, August, 1954" *Papers, Department of Zoology, University of Queensland*, (1)4, p.1-59, 1956
  - W. Stephenson, R. Endean and I. Bennett "An ecological survey of the marine fauna of Low Isles, Queensland", *Australian Journal of Marine and Freshwater Research*, 9, 1958. pp.261-318.
16. The very first expedition by the Committee was led by Richards and Hedley around the "reefs, islands and headlands between Cairns and Booby Island" in 1923. (Hill, 1984. pp. 3-5)
17. Hill, 1984. p.2.

18. Dr. G.F. Humphrey wrote a brief paper that was included in the first *Australian Marine Science Newsletter*, July 1963, entitled "The CSIRO Division of Fisheries and Oceanography", pp. 5-6. More historical detail is found in Annex A of a report by Dr. K. Radway Allen, then Chief of the CSIRO's Division of Fisheries and Oceanography, *An Outline of the Present Status of Marine Science in Australia* that was submitted to ASTEC on 27 October 1975.
19. McKay, Andrew *Surprise and Enterprise - Fifty Years of Science for Australia*, CSIRO, 1976, p.4.
20. Wild, Paul, *CSIRO 1978-83: Years of Change, A Report by the Chairman of CSIRO, Dr. J. Paul Wild*, CSIRO, 1984, p.8.
21. Oceanography did receive priority status as a growth area at CSIRO for two years in the early 1980s. See Wild (1984), pp. 10-12.
22. See "Oceanography in Australia" in *Occasional Papers in Maritime Affairs:4, Maritime Australia: Exploring the Scientific and Technological Base*, Canberra: Australian Centre for Maritime Studies, 1987, p.26-37 by Angus McEwan, Director of CSIRO's present Division of Oceanography at Hobart.
23. McEwan, A., 1987, p.36.
24. Historical data provided by David Falvey, Chief Research Scientist, Division of Marine Geosciences and Petroleum Geology, BMR, personal correspondence to Dr. Joe Baker, 4 February 1988.
25. An overview paper by the Australian Fisheries Service (DPI) entitled "Fisheries Research and Development in Australia" (*Australian Fisheries*, Vol.43, No.12, December 1984, p. 14-20) goes into detail on the administration of Australian fisheries research. A bibliography is also provided on relevant fisheries papers. See also by the Australian Fisheries Service, "Fisheries Research and Development", *Australian Fisheries*, Vol.44, No.2, February 1985, pp. 14-15.
26. See earlier discussion - p. 5, Marine Science in Australia: Pre-1920s.
27. See Section III(C) of this report - Envisaging a Tropical Marine Science Institute.
28. Sources of State research funds, expenditure and allocation is summarised in *Australian Fisheries*, Dec.1984, p.17, Table 7.
29. Correspondence from Darryl Grey, Director of Research, Northern Territory Fisheries Dept. to Dr. Joe Baker, Director, AIMS. 14 October 1987.
30. Correspondence from D.A. Pollard, Senior Research Scientist, New South Wales Government, Dept. of Agriculture, Fisheries Research Institute to Dr. Joe Baker, Director AIMS. 13 October 1987.
31. S.J.Edmonds, 1986, pp. 204-206.

32. Correspondence from A.J. Harrison, A/Deputy Director, Department of Sea Fisheries Tasmania to Dr. Joe Baker, Director AIMS. 14 October 1987.
33. Other research is also carried out by the WA Branch of the AFIC, Murdoch University, the W.A. Museum, and the Division of Fisheries CSIRO. (B.K.Bowen, Director, Department of Fisheries and Wildlife, Western Australia. "Research and Development Issues" in *Australian Fisheries Conference - Fisheries Research and Development*, 1985, p.5.1.
34. See 1985 Australian Marine Research In Progress.
35. See History of Victorian Marine and Fisheries Research (Within Government Organisations), First draft and "framework" by C.F. Gibbs, 22 Feb 1988.
36. For details, see Publication No.284 in the Ministry for Conservation, Victoria, Environmental Studies Series. "Summary of the work of the Marine Studies Branch of the Environmental Studies Division, Ministry for Conservation, November 1968 to December 1979, with a list of Publications and Reports".
37. Ministry for Conservation, Marine Science Laboratories, Fisheries and Wildlife Research Committee. Marine Science Laboratories - Research Activities, Submission prepared for the November 1982 meeting by Allan J. Bremner, Acting Director M.S.L., 21 October 1982.
38. State of Victoria, *Victorian Institute of Marine Sciences Act 1974*, Section 4.(1).
39. J.M Thomson, A Short History of the Australian Marine Sciences Association, *Australian Marine Science Bulletin*, No.90, April 1985, pp. 20-25.
40. See AMSA's first newsletter *Australian Marine Sciences Newsletter*, July 1963 for insight into the early plans and sentiments of its founding members.
41. Objects of AMSA, *Australian Marine Science Bulletin*, No. 96, October 1986.
42. In a 1970 Symposium on Marine Sciences by the Australian Academy of Science, B.R.Morton commented "To a limited degree the Australian Marine Sciences Association (AMSA) provides contacts, but it caters for a wide spectrum of scientific and professional interests and cannot provide the intensive interaction needed for research stimulation." Morton, B.R. (Chairman ANCOR) "Steps Towards a National Policy for the Marine Sciences", Report No. 12, *Symposium on Marine Sciences*, R.J.Walsh (ed), Australian Academy of Science: Canberra. May 1970, p.6.
43. S.J.Edmonds, 1986, p.175.
44. P.F. Berry, Western Australian Museum, personal correspondence to Dr. Joe Baker, 9 February 1988.



45. In the collection of material and in writing his most famous book, *Australian Seashores* (Australia: Angus & Robertson Publishers, 1952) that was published only after his death, Professor Dakin was provided invaluable assistance by two other dedicated enthusiasts over the years - Isobel Bennett (University of Sydney) and Elizabeth Pope (Australian Museum).
46. Personal interview with Dr. M.F. Day, former CSIRO Executive and Chairman of the AIMS Interim Council, 4 August 1987.
47. Bennett's list of books includes:
  - *The Great Barrier Reef*, Dee Why West: Lansdowne Press, 1971;
  - *The Fringe of the Sea*, Adelaide: Rigby, 1966;
  - *On the Australian Seashore*, Adelaide: Rigby, 1974;
  - *Shores of Macquarie Island*, Adelaide: Rigby, 1971;
  - *Discovering Lord Howe Island* (with Jean Edgecombe), and *A Coral Reef Handbook: A Guide to the fauna, flora and geology of Heron Island and adjacent reefs and cays* (2nd edition), P. Mather and I. Bennett (eds), Brisbane: Australian Coral Reef Society, 1984.
48. P. Mather, The Queensland Museum and Marine Research, personal correspondence to Dr. Joe Baker, 8 February 1988.
49. P. Mather & F.H. Talbot, August 1975, p.335. (In 1969 the University of Queensland became joint owner and operator with the Great Barrier Reef Committee of the Heron Island Research Station and today is the sole owner and operator of the Station.)
50. Dr. D. Griffin, Australian Museum, 'Australian Museum Marine Science History' personal correspondence to Dr. Joe Baker, 8 February 1988.
51. Dr. John K. Ling, South Australian Museum, 'The South Australian Museum's Involvement in Marine Research', personal correspondence to Dr. Joe Baker, 8 February 1988.
52. P.F. Berry, personal correspondence to Dr. Joe Baker, 9 February 1988.
53. P. Mather, Queensland Museum, Pers. Corresp., 8 Feb. 1988.
54. G.C.B. Poore, Museum of Victoria, 'Marine Science in Museum of Victoria', Personal correspondence to Joe Baker, 12 February 1988.
55. The AUC was set up in 1959. In the AUC's *Second Report of the Australian Universities Commission on Australian Universities 1961-1966* (published in 1963) the Commission recommended that a capital grant of 10,000 pounds be provided the University of Queensland "as the facilities for research on Heron Island are not in good order...". Further evidence of the AUC's sensitivity to the need for more marine research is its recommendation in its *Fourth Report* published in May 1969 that recommended a grant of \$620,000 to the University College of Townsville for an extension to its Biological Sciences Building, explaining "the additional space is intended to permit the further development of work in Tropical Marine Biology and the introduction of work in Tropical Veterinary Sciences."

56. Data presented by The Honourable Senator J. Keefe (Qld) during his speech on 10 June 1970 to the Senate. Commonwealth of Australia, *Parliamentary Debates*, Vol. S. 44 1970, 'Second Reading of the Australian Institute of Marine Science Bill', 10 June 1970, p.2254.
57. *Marine Science in Australia, Report of the Interim Council of the Australian Institute of Marine Science*, 1971, p.48.
58. ANCOR, a committee of the Australian Academy of Science, is now called ANCOS, 'Research' having been replaced by 'Sciences'.
59. Morton, B.R., 1970, pp. 67-68.
60. K. Radway Allen, *An Outline of the Present Status of Marine Science in Australia*, A Report Prepared for the Australian Science and Technology Council On Behalf of the CSIRO Division of Fisheries and Oceanography, 1977, pp.11, 27.
61. *The Australian Marine Research in Progress*, (AMRIP), published in 1982, 1983, and 1985 provides a reference source for specific ongoing marine research projects.
62. See Chapter 17: Education for the Sciences, p.17-58. Commonwealth of Australia, *Tertiary Education in Australia - report of the Committee on the Future of Tertiary Education in Australia to the Australian Universities Commission*, Vol.III, August 1965.
63. These include the *Antarctic Treaty Act 1960*, the *Continental Shelf (Living Natural Resources) Act 1968*, *Fisheries Act 1952*, *Income Tax Assessment Act 1936*, *Petroleum (Submerged Lands) Act 1967*, and the *Quarantine Act 1908*.
64. The State of Victoria, which adopted the Strategy in 1986, was in 1987 the only State that had done so.
65. United Nations Economic and Social Council, *The Sea, Prevention and Control of Marine Pollution*, UN Doc.E/5003 (1 May 1971). M.Waldichuk, *Global marine pollution: an overview*, *IOC Technical Series No.18*, UNESCO 1977, pp. 72-75.
66. A thorough history and legal analysis of the subject is provided by Soons, Alfred H.A., *Marine Scientific Research and the Law of the Sea*, The Hague: Kluwer Law and Taxation Publishers, 1982.
67. Commonwealth of Australia, *Parliamentary Debates*, House of Representatives, Volume H of R 66, 1969 1970, Australian Institute of Marine Sciences Bill, Second Reading, p.1475.
68. These include the *Environment Protection (Sea Dumping) Act 1981*, the *Great Barrier Reef Marine Park Act 1975*, the *Navigation (Protection of the Sea) Amendment Act 1983*, the *Protection of the Sea (Civil Liability) Act 1981*, the *Protection of the Sea (Discharge of Oil from Ships) Act 1981*, the *Protection of the Sea (Powers of Intervention) Act 1981*, the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983*, *Protection of the Sea (Shipping Levy) Act 1981*, *Protection of the Sea (Shipping Levy Collection) Act 1981*, the *Antarctic Marine Living Resources Conservation Act 1981*, the *Antarctic Treaty (Environment Protection) Act 1980*, the *Australian Heritage Commission Act*



1975, the *Australian Institute of Marine Science Act 1972*, the *National Parks and Wildlife Conservation Act 1975*, the *Whale Protection Act 1980*, and the *World Heritage Properties Conservation Act 1983*.

69. Convention for the Protection of the World Cultural and Natural Heritage (Paris, 23 November 1972). Entry into force: 17 December 1975, Department of Foreign Affairs, Canberra: AGPS, 1976.
70. Royal Commission Report, 1974, p.18.
71. Professor Birch who chaired the inquiry into the CSIRO was Chairman of the Australian Marine Sciences and Technologies Committee (AMSTAC) during this period and became a strong advocate for an increased Government commitment to marine scientific and technological research in general. He was also a strong supporter of international collaboration in research.
72. Parliament of the Commonwealth of Australia. *Independent Inquiry into the Commonwealth Scientific and Industrial Research Organization*. Parliamentary Paper No.283/1977. Canberra: Commonwealth Government Printer, August 1977, p.17.
73. Ibid, p.18.
74. Senator Dittmer (Queensland). Commonwealth of Australia *Parliamentary Debates*, Senate. Vol. S. 15. Estimates and Budget Papers 1959-60, 27 August 1959, p.354.
75. Senator Dittmer (Queensland). Commonwealth of Australia *Parliamentary Debates*, Vol. S. 31. Proposed Expenditure 1963-64, 25 September 1963, p.833.
76. University College of Townsville, Submission to the Australian Universities Commission for the 1967/69 Triennium. James Cook University Archives.
77. Commonwealth of Australia. *Third Report of the Australian Universities Commission - Australian Universities 1964-1969*, August 1966, p.120.
78. University College of Townsville, *The Supplementary Submission For Biological Sciences To The Australian Universities Commission*, July 1968, p.1.
79. Ibid, 1968, pp. 1-2.
80. The AUC Fifth Report, May 1972, p.4 "Special Enquiries" reviews the opinion and letter written in 1969 by the AUC to the Minister about the proposed institute.
81. AIMS Archives. Federal Election 1969 Policy Speech, Presented by the Prime Minister (The Right Hon. John Gorton) over TV and radio stations throughout Australia on Wednesday, October 8, 1969.
82. Bowen, N.H., *Australian Institute of Marine Science Bill*, Second Reading [4 March 1970]. Commonwealth of Australia, *Parliamentary Debates*, Volume H. of R. 66, 1969-70. p.86.



83. Patterson, Dr. R. (M.P.Dawson). Second Reading of the *Australian Institute of Marine Science Bill* 1970, Commonwealth of Australia, *Parliamentary Debates*, 22 April 1970, Vol. H. of R. 66, 1969-70, P.1472.
84. Ibid, p.1474.
85. Bowen,L. 'Second Reading of the *Australian Institute of Marine Science Bill* 1970, Commonwealth of Australia, *Parliamentary Debates*, 8 May 1970, Vol. H. of R. 66, 1969-70. p.1935.
86. The Hon. Mr. D.Cameron.M.P. 'Second Reading of the *Australian Institute of Marine Science Bill* 1970, Commonwealth of Australia, *Parliamentary Debates*, 21 May 1970, Vol.H. of R. 67, p.2575.
87. M.F.C. Day, Planning for the Australian Institute of Marine Science in Townsville, (For Presentation at the Annual Meeting of the Australian Marine Science Association, Sydney, August 12, 1972) AIMS Archives, File 2/29/20, Part 72/12.
88. Ibid, p.5.
89. The members of the Council included Dr. M.F.Day, member of the CSIRO Executive (Chairman); Professor C. Burdon-Jones, Professor of Marine Biology at James Cook University; Dr. N.H.Fisher, Director of the Commonwealth Bureau of Mineral Resources, Geology and Geophysics; Professor D. Hill, Research Professor of Geology from the University of Queensland, Mr.Walter Ives, Secretary of the Department of Primary Industry; Dr. D.F. McMichael, Director of the Australian National Parks and Wildlife Service; and Professor R.J. Walsh, Professor of Human Genetics at the University of New South Wales and nominated by the Australian Academy of Science.
90. That report was entitled *Marine Science in Australia - Report of the Interim Council of the Australian Insitute of Marine Science*, CSIRO: Melbourne (1971). Five months earlier, in February 1971, the Interim Council had submitted a more explicit and radical draft to Mr. Fairbairn. However Mr. Fairbairn had taken issue with the Interim Council's suggestion that the proposed Australian Marine Science Council "should take over in due course the responsibility for marine research which now rests with CSIRO and is carried out by its Division of Fisheries and Oceanography." (*Marine Science in Australia, Report of the Interim Council of the Australian Institute of Marine Science* (Draft), February 1971, p.45, para.152, AIMS Archives Doc. 71/18) In a letter to Dr. M.F. Day the Minister stated that "the Interim Council had exceeded its terms of reference in making a recommendation on the future of the CSIRO Division of Fisheries and Oceanography." The Minister also advised Dr. Day that the Interim Council's "wide ranging proposals for the establishment of an Australian Marine Science Council and a Marine Research Fund" also seemed outside the terms of reference but "my concern with these proposals however is not such as would lead me to suggest that they should be modified. When the final report is submitted I shall decide which of the recommendations I will support." (29 June 1971, AIMS Archives, MS 19, No.292) The Interim Council agreed to modify its report by deleting all specific references to the future of CSIRO's marine science division and the report was resubmitted in July. (A letter from Interim Council Chairman M.F. Day to Dr. N.H. Fisher and all other Council members, 2 July 1971 outlines in detail the changes made to the February Draft Report.)

91. Specifically the seven major recommendations were: (1)that the most appropriate site for the Institute was Cape Pallerenda at Townsville; (2)that initial costs were estimated at \$3.9 million and when the facility was fully completed by 1977 the running costs would total \$1.3 million annually (based on 1971 dollars); (3)that the Institute should acquire two research vessels of length 80 ft. and 120 ft.; (4)that staff should ultimately total 130 including 24 research scientists; (5)that the research emphasis should be directed initially on scientific problems of the Great Barrier Reef, the Coral Sea, and the coast and coastal waters of north Queensland; (6)that an AIMS Council should function as a governing body for the Institute while also having responsibility for the coordination and development of marine science in Australia; and (7)that a Marine Research Fund should be established, under AIMS Council control, to promote the development of marine science in universities, museums, and other institutions.
92. The Hon. Malcolm Fraser.M.P., Minister for Education and Science, Second Reading of the Australian Institute of Marine Science Bill 1972, 23 March 1972, Commonwealth of Australia *Parliamentary Debates*, Vol. H. of R. 76, 1972, pp. 1136-1140.
93. The Hon. Mr.Beazely during the Second Reading of the Australian Institute of Marine Science Bill 1972, Commonwealth of Australia, *Parliamentary Debates*, Vol. H.of R.78, 17 May 1972, p.2716, 2718.
94. The Hon. Senator Georges, Second Reading of the Australian Institute of Marine Science Bill 1972, Commonwealth of Australia *Parliamentary Debates*, Vol. S. 52, 1 June 1972, p.2448.
95. Not only was the site less than ideal due to the pollution of local waters from the nearby nickel smelter, but it was also learned that the Royal Australian Air Force and Department of Civil Aviation had been granted permission to install a radar on the Many Peaks Range near the site. Experts advised that an unacceptable level of interference to the Institute's scientific laboratory equipment could result. The Bill was amended in March 1973 to remove the site restriction clause as a new home was sought. Australian Institute of Marine Science Bill 1973, presented by The Hon. Mr. Morrison, Minister for Science and Minister for External Territories, Commonwealth of Australia *Parliamentary Debates*, Vol. H.of R. 83, 11 April 1973, p.1314.
96. The topics selected for study in the first years of scientific operations were:
  1. Tropical marine food webs.
  2. Coral reefs and Reef-building organisms, and
  3. Marine Pollution.In 1979 Physical Oceanography was added to this list.
97. "The main geographic area of interest of all of AIMS research is presently directed to the coastal and continental shelf regions of Tropical Australia. The research programmes are essentially directed to achieving an understanding of the marine environment in this area. The geographical restriction reflects AIMS' financial, technical and operational capabilities (particularly shipping) and its understanding with other national agencies (AMSTAC, CSIRO, GBRMPA, BMR), and Universities which work in oceans surrounding



Australia." AIMS Council policy statement, *Australian Institute of Marine Science Projected Research Activities 1986 - 1991*, Townsville: AIMS, p.2.

98. Other research areas included humanities and social sciences, physical sciences, chemical sciences, biological sciences, earth sciences, engineering and applied sciences, upper atmosphere, and multidisciplinary.
99. *ARGC Report 1973-75*, AGPS:Canberra, 1976, p.16.
100. Monies allotted: \$243,654 in 1973; \$303,670 in 1974; and \$428,952 in 1975 totalling \$976,276.( *ARGC Report 1973-75*, pp. 20-23).
101. Morrison, W.L., Minister for Science, *Towards an Australian Science Council*, AGPS: Canberra, March 1974, p.1.
102. These figures do not include off-shore oil and gas exploration R&D, RAN's and Division of National Mapping's hydrography work, or defence-related R&D. (*ASTEC, Science and Technology in Australia 1977-78*, Vol. 2, p.197.
103. *Ibid*, p.196.
104. *Ibid*, p.197, para. 21.1.23. The three university groups included the Marine Studies Centre, University of Sydney; Flinders Institute for Atmospheric and Marine Sciences, Flinders University of South Australia; and Committee on Marine Science, University of Melbourne.
105. *ASTEC, Science and Technology in Australia 1977-78*, A Report to the Prime Minister by ASTEC, Volume 1A, June 1978, AGPS: Canberra, p.123.
106. *Ibid*, Summary and Recommendations, February 1979, p.8.
107. *Ibid*, p.8
108. AMSTAC Committee Paper. "The Future for AMSTAC", Doc.No. M54/86, p.2.
109. *ASTEC, Marine Sciences and Technologies in Australia: Immediate Issues*, July 1979, p.3.
110. *Ibid*, p.2.
111. Terms of reference of the Senate Standing Committee for Science and the Environment, p.viii of *Australian Marine Science*, Report from the Senate Standing Committee on Science and the Environment, Canberra: AGPS, June 1981.
112. Assistance schemes to industry include the 150 percent taxation concession for R&D expenditure, the Grants for Industrial Research and Development Scheme (GIRDS), providing development and venture finance through the Australian Industry Development Corporation (AIRDIS) and the Mangement and Investment Companies Scheme (MIC), the National Industry Extension Service, a revised Offsets Program, and a number of programs for small businesses. See *Building International Competitiveness* published for the Dept of Industry, Technology and Commerce, Canberra: AGPS, 1987.



113. Parliament of the Commonwealth of Australia, *Australian Marine Science, Report from the Senate Standing Committee on Science and the Environment*, Canberra: AGPS. p. x-xiii, June 1981.
114. Ibid, 1981, pp. 1-2.
115. *Australian Marine Science, Report by the Senate Standing Committee on Science and the Environment: Government Response*, Statement by Senator The Hon. Peter Durack, Q.C., Minister Representing the Minister for Science and Technology, Commonwealth of Australia, *Parliamentary Debates*, Vol. S 92, 26 November 1981, p.2626.
116. Ibid, 1981, p.2626.
117. A short list of published AMSTAC documents includes:  
*Marine Sciences & Technologies in Australia: Priorities For Additional Research & Development 1980 - 81*, April 1980  
*Towards a Marine Sciences and Technologies Program for the 1980s*, May 1981  
*AMSTAC Annual Report 1981-82*  
*AMSTAC Annual Report 1983*  
*Priorities for the 1983-84 Budget*  
*AMSTAC Annual Report 13 Dec 1984*  
*Priorities for the 1984-85 Budget*  
*AMSTAC Annual Report 1985/86*  
 There have also been number of Working Group reports (Re: Vessels, Marine Taxonomy, Coastal and Ocean Engineering, National Facilities, etc.) whose conclusions and recommendations have been incorporated into AMSTAC's yearly recommendations to the Government.
118. The 1987 reorganisation is discussed later in this report, Section V. FUTURE TRENDS IN AUSTRALIAN MARINE SCIENCE POLICY.
119. See(1) AMSTAC, *Marine Co-ordination Workshop, 1985 Marine Research Plans of Federal Agencies*, 1985  
 (2) AMSTAC, *Marine Science and Technology Workshop*, April 1986.
120. For a brief history of FASTS' conception and earliest activity, see the article by L.Hammond, *AMSA Bulletin*. No.93, January 1986, pp. 7-8.
121. Windrup, Dr. D., Executive Director FASTS, Correspondence to The Hon. J.S. Dawkins, Minister for Employment Education and Training, 12 August 1987.
122. See J.M Thomson. 1985. pp. 24-25.
123. A brief historical sketch of APOC was provided by George Creswell (Chairman, Physical Oceanography Division, AMSA) at the AMSA-APOC Conference and is reprinted in *AMSA Bulletin* No.99, July 1987, pp. 9-10.
124. Personal interview by phone with Dr. David Johnson, Deputy Chairman of COGS. Department of Geology. James Cook University, 21 December 1987.

125. The ACMS journal *Maritime Studies* is published six times each year. There have also been four volumes of *Occasional Papers in Maritime Affairs*. See especially "Maritime Australia: Exploring the Scientific and Technological Base", Volume 4, 1987.
126. WESTPAC hosted a major symposium in Townsville, Qld in December 1986 entitled - Marine Science in the Western Pacific: The Indo-Pacific Convergence. Assistance was given in preparing and organising the event from AIMS, the Great Barrier Reef Marine Park Authority, James Cook University, and the Sir George Fisher Centre for Tropical Marine Studies.
127. AMSTAC, *The Marine Sciences and Technologies Grants Scheme, A review by the AMSTAC*, July, 1986, p.57.
128. Marine Research Allocations Advisory Committee, *Report on Marine Sciences and Technologies Grants for 1987*, 'Funding policies for 1987 grants', p.3.
129. Sources:
  - Report to AMSTAC Coordination Workshop, Canberra April 1985 by Professor Kevin P. Stark, Chairman, Marine Research Allocations Advisory Committee (MRAAC)
  - MRAAC, *Report on Marine Sciences and Technologies Grants for 1987*, Canberra: Department of Science, p.2.
130. The 1983/84 year causes problems for statistical analysis since the funding practice changed from financial to real calendar years. The inflated 83/84 amount accounts for 18 months rather than 12. Nevertheless the increase that year was real in the sense that the average funding for a single grant rose to its highest level (\$31,000) during that period. Also, the following years were funded at a level comparable to that of 1983/84.
131. The long-standing Chairman of the Marine Sciences and Technologies Grants Scheme, Prof. Kevin P. Stark, is himself an engineer and is most interested in furthering the progress of engineering research in Australia.
132. Within this category those projects located on the East Australian coast dominated. The reader is referred to MRAAC, *Report on Marine Sciences and Technologies Grants for 1985*, p.8, and the same for 1986, p.9 for a complete breakdown between regions. Regional statistics were not compiled in as detailed or standardized a way during the entire seven year period so are not presented in this report.
133. Percentages for the years 1980 - 1986 were based on figures provided by AMSTAC, *The Marine Sciences and Technologies Grants Scheme, A review by AMSTAC*, July 1986, p.16 and for the year 1979 by the MSTGS *Report of Grants Approved for 1980/81*.
134. The location of the marine research stations are: University of Sydney - One Tree Island; University of Queensland - Heron Island; James Cook University - Orpheus Island; and University of Western Australia - Rottnest Island.



135. See the Marine Research Allocations Advisory Committee's *Report on Marine Sciences and Technologies Grants for 1986*, pp.11-13.
136. MRAAC, *Marine Sciences and Technologies Grants Scheme, Meeting with Minister for Science, Mr. B.O.Jones*, Discussion of AMSTAC Report on The Marine Sciences and Technologies Grants Scheme (MSTGS), 3 September 1986, Melbourne, pp. 5-6.
137. Data based on the figure \$.55 million provided in the 1986 AMSTAC Report on MSTGS, Table 10: Federal Expenditure on Marine Science and Technology, p.39 and from the ARGS *Report on Grants Approved for 1987* that states that the 1986 ARGS allocation was \$27.54 million.
138. Bottrill, D. "Detailed Analysis of the FIRTA Program over the years 1979 to 1982", *Australian Fisheries Conference - Fisheries Research and Development*, Canberra Jan 31 - Feb 2 1985, p.4.3.
139. An explanation of the aims of FIRTA and a breakdown of the 1987-88 grants by value, numbers and fishery is provided in the August and September 1987 issues of *Australian Fisheries*, Vol.46, Nos.8 (p.10-18) and 9. More background information is available in *Australian Fisheries Conference - Fisheries Research and Development*, papers presented Jan 31 - Feb 2 1985. Canberra: DPI, 1985.
140. See National Research Fellowships Advisory Committee, *Report on Fellowships awarded for 1986*, Canberra: Department of Science, 1986, p.12-13.
141. The distinction made in this analysis between funds spent on ecology vs. those spent on marine biology at AIMS is an imprecise one since the scientific disciplines often overlap.
142. The AMSTAC paper *National Needs and Priorities for Coastal and Ocean Engineering Hydraulic Laboratory Facilities* (November 1983) discusses this issue in depth. See also the papers by the Institution of Engineers, Australia and by J. Hinwood (Bibliography).
143. CSIRO Division of Fisheries Research contribution to AMSTAC Coordination Workshop, 25 June 1987, Canberra.
144. CSIRO Division of Oceanography, "Information Paper prepared for the AMSTAC Coordination Workshop - 21 April 1986", *Marine Science and Technology Coordination Workshop*, Canberra: AMSTAC, pp.113-131, April 1986.
145. AIMS, "Contribution to AMSTAC Coordination Workshop", 21 April 1986, *Marine Science and Technology Coordination Workshop*, pp.77-88, April 1986.
146. "BMR Program: Marine Geoscience in the National Interest", *Marine Science and Technology Coordination Workshop*, p.217.
147. This distinction is important because of the status of the Great Barrier Reef Marine Park as an area protected from all commercial mineral (including hydrocarbon) exploitation.



148. David Falvey, personal correspondence to Dr. Joe Baker, 'History of Marine Geosciences in BMR', 4 February 1988
149. See (1) Dr. R Bain, "Commonwealth fisheries policies - problems, priorities and progress", *Australian Fisheries*, Vol.43, No.8, August 1984, p.14-18 and (2) "The Australian Fisheries Service - Marine Science and Technology Responsibilities", *Marine Science and Technology Coordination Workshop*, April 1986. pp. 70-74.
150. Australian Fisheries Conference, "Fisheries Research and Development", *Australian Fisheries*, Vol.44, No.2, February 1985, p.14.
151. See *Australian Fisheries*, Vol.43, No.8, August 1984, pp. 10-12.
152. Personal phone contact with Dr. P. Quilty, Antarctic Division, 29 October 1987.
153. The Antarctic Division's Marine Science Program, pp.165-168 in AMSTAC's *Marine Science and Technology Coordination Workshop*, April 1986.
154. See submission to AMSTAC Coordination Workshop, April 1986, pp.91-94.
155. *National Parks and Wildlife Conservation Act 1975*.
156. Australian National Parks and Wildlife Service: Marine Responsibilities, *Marine Science and Technology Coordination Workshop*, April 1986, pp.18-32.
157. Background Information from Department of Housing and Construction, *Marine Science and Technology Coordination Workshop*, April 1986, pp.97-99.
158. Some further details are provided in DSTO's submission to AMSTAC for the 1986 Workshop, pp.101-108.
159. See RAN's submission to AMSTAC, April 1986, pp.201-213.
160. Section 6 (1)(g).
161. The Bureau's 1986 submission to the AMSTAC Coordination Workshop is a detailed and interesting presentation of its marine-related work (pp.133-164).
162. See the Table *Commonwealth Budget Allocations for Marine Science and Technology*, p.15 in AMSTAC's *Marine Science and Technology Coordination Workshop*, April 1986.
163. "Paper by Department of Transport", AMSTAC *Marine Science and Technology Coordination Workshop*, April 1986. pp. 188-191.
164. AMSTAC, "Review of the Workshop", *Marine Science and Technology Coordination Workshop*, April 1986, p.255.
165. 1982 Labor Party Policy Platform, Chapter 19, Sections 48 - 50, p 152.

166. Commonwealth of Australia, Department of Science, Towards a Commonwealth Policy for Marine Science and Technology, A review of the basis for Commonwealth involvement in and support of marine science and technology in Australia, DOS File No. 82/1339, 18 pages.
167. Swan, J.M., Chairman AMSTAC. Correspondence to Dr. W.J. McG. Tegart, Secretary of the Department of Science and Technology, 25 November 1982. DOS File No 82/1339.
168. These concerns were summarised in a briefing paper by D.G. Keeley at the Department of Science and Technology, entitled 'Towards a Commonwealth Policy for Marine Science and Technology' Meeting with AMSTAC, 9 December 1982, DOS&T File No. 82/1339.
169. Department of Science and Technology, memo from D.G. Keeley to FASPOL, 9 November 1983, DOS&T File No. 82/1339.
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171. ASTEC "Comments on Proposed Statement on The Australian Governments's Role in Marine Science and Technology" submitted to The Hon. R.J.L. Hawke, 20 November 1984, p.2, DOS File No. 84/4266.
172. Ibid, p.5.
173. Following the Minister's 16 August 1984 letter, replies were received from CSIRO, AIMS, DOS Antarctic Division, the Bureau of Meteorology, and the Ministers for Finance; Trade; Home Affairs and Environment; Primary Industry; Housing and Construction; Sport, Recreation and Tourism; Defence; Resources and Energy; Transport; and Foreign Affairs. DOS File No.84/4266.
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In some cases abbreviations have been used to reduce the length of index entries. The reader is referred to the abbreviations list on page iv.

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